US010009501B2

(12) **United States Patent**
Suzuki et al.

(10) **Patent No.: US 10,009,501 B2**
(45) **Date of Patent: Jun. 26, 2018**

(54) **OPTICAL PRINT HEAD, IMAGE FORMING APPARATUS, AND METHOD OF MANUFACTURING THE OPTICAL PRINT HEAD**

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(72) Inventors: **Takahito Suzuki**, Tokyo (JP); **Manabu Imai**, Tokyo (JP); **Masamitsu Nagamine**, Tokyo (JP)

(73) Assignee: **Oki Data Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days. days.

(21) Appl. No.: **15/474,116**

(22) Filed: **Mar. 30, 2017**

(65) **Prior Publication Data**

US 2017/0289384 A1 Oct. 5, 2017

(30) **Foreign Application Priority Data**

Mar. 31, 2016 (JP) 2016-070661

(51) **Int. Cl.**
H04N 1/04 (2006.01)
H04N 1/028 (2006.01)

(52) **U.S. Cl.**
CPC . ***H04N 1/02845*** (2013.01); *H04N 2201/0094* (2013.01)

(58) **Field of Classification Search**
CPC G02F 2001/13625; G02F 1/133365; G06K 15/1247; G06K 15/12; G06K 15/1238; G06K 15/1252; G06K 15/1257; G06K 15/1295; H04N 1/02815; H04N 1/02845; H04N 1/02855; H04N 1/02865; H04N 1/02895
USPC 355/53, 43, 46, 67, 405, 41, 52, 55, 71; 348/125, 126, 129, 127, 128, 87, 92; 358/302, 296; 362/311.01, 311.02, 330, 362/396, 457
See application file for complete search history.

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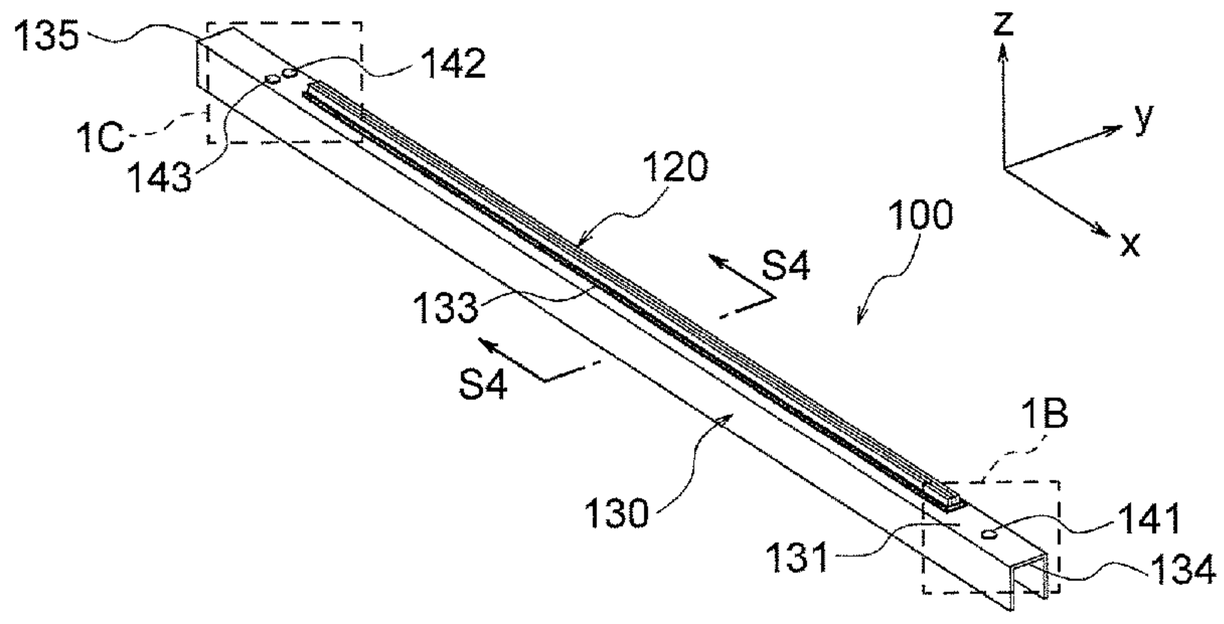
Primary Examiner — Negussie Worku
(74) *Attorney, Agent, or Firm* — Panitch Schwarze Belisario & Nadel LLP

(57) **ABSTRACT**

An optical print head for illuminating an image carrier facing the optical print head includes: a substrate on which a light emitting element array is mounted; a lens array for focusing light emitted from the light emitting element array onto the image carrier; a holder holding the substrate and the lens array; and at least one spacer member, disposed on the holder, for maintaining a predetermined distance between the lens array and the image carrier, the at least one spacer member being made of curable resin that is cured under a predetermined condition or fixed to the holder with curable adhesive that is cured under a predetermined condition.

17 Claims, 22 Drawing Sheets



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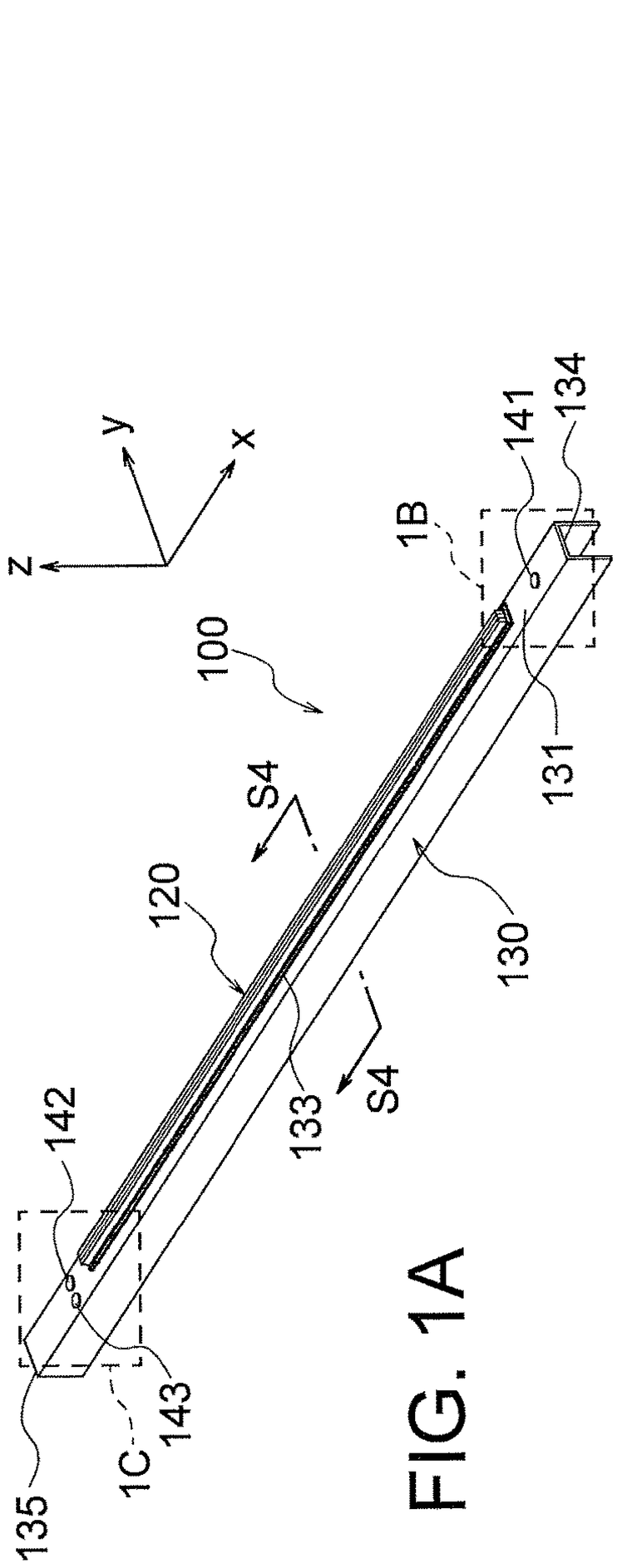

FIG. 1A

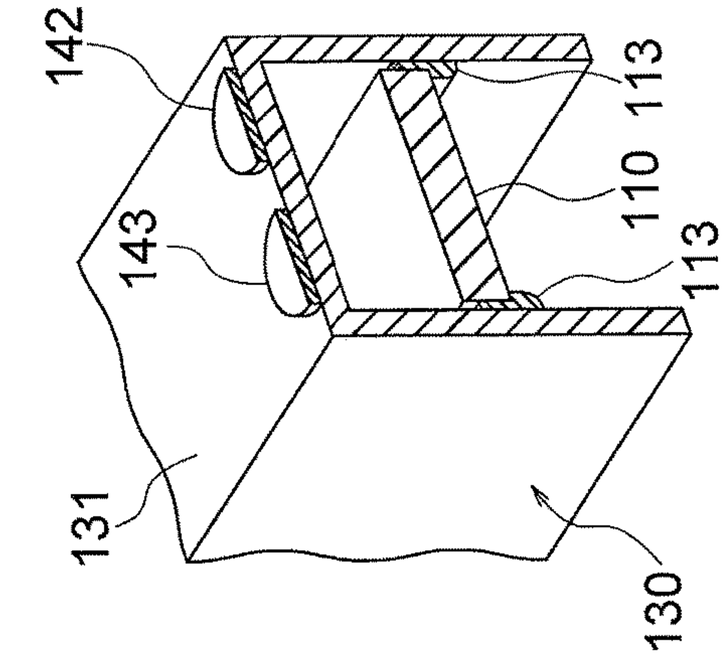

FIG. 1C

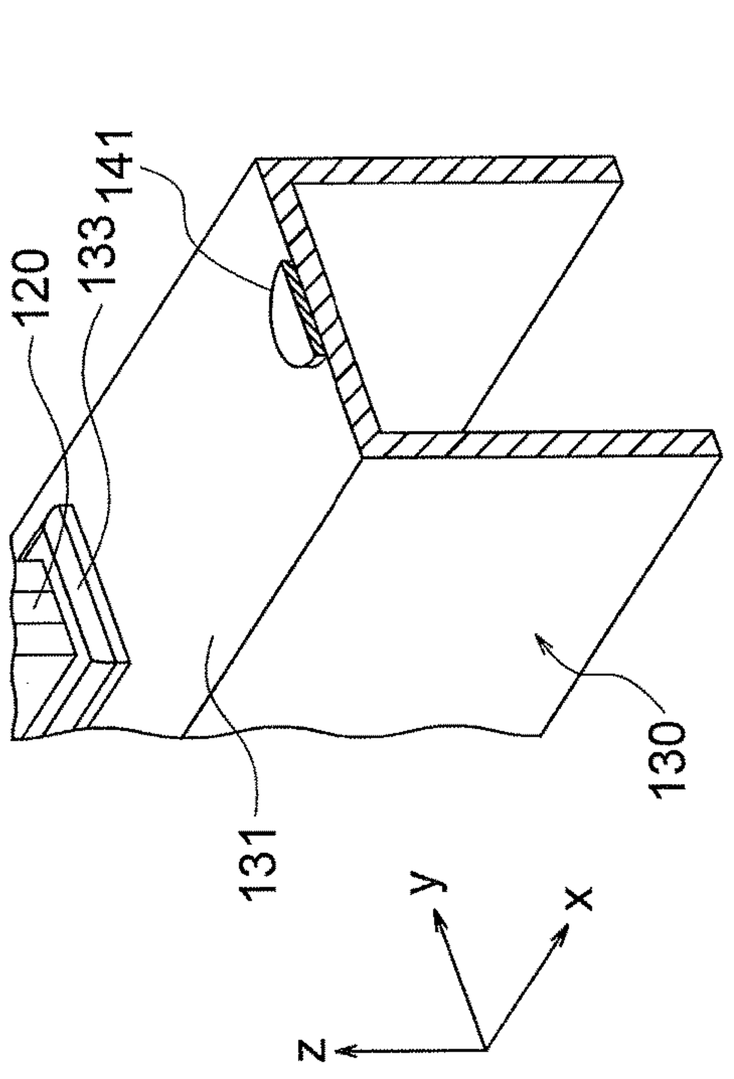

FIG. 1B

FIG. 2

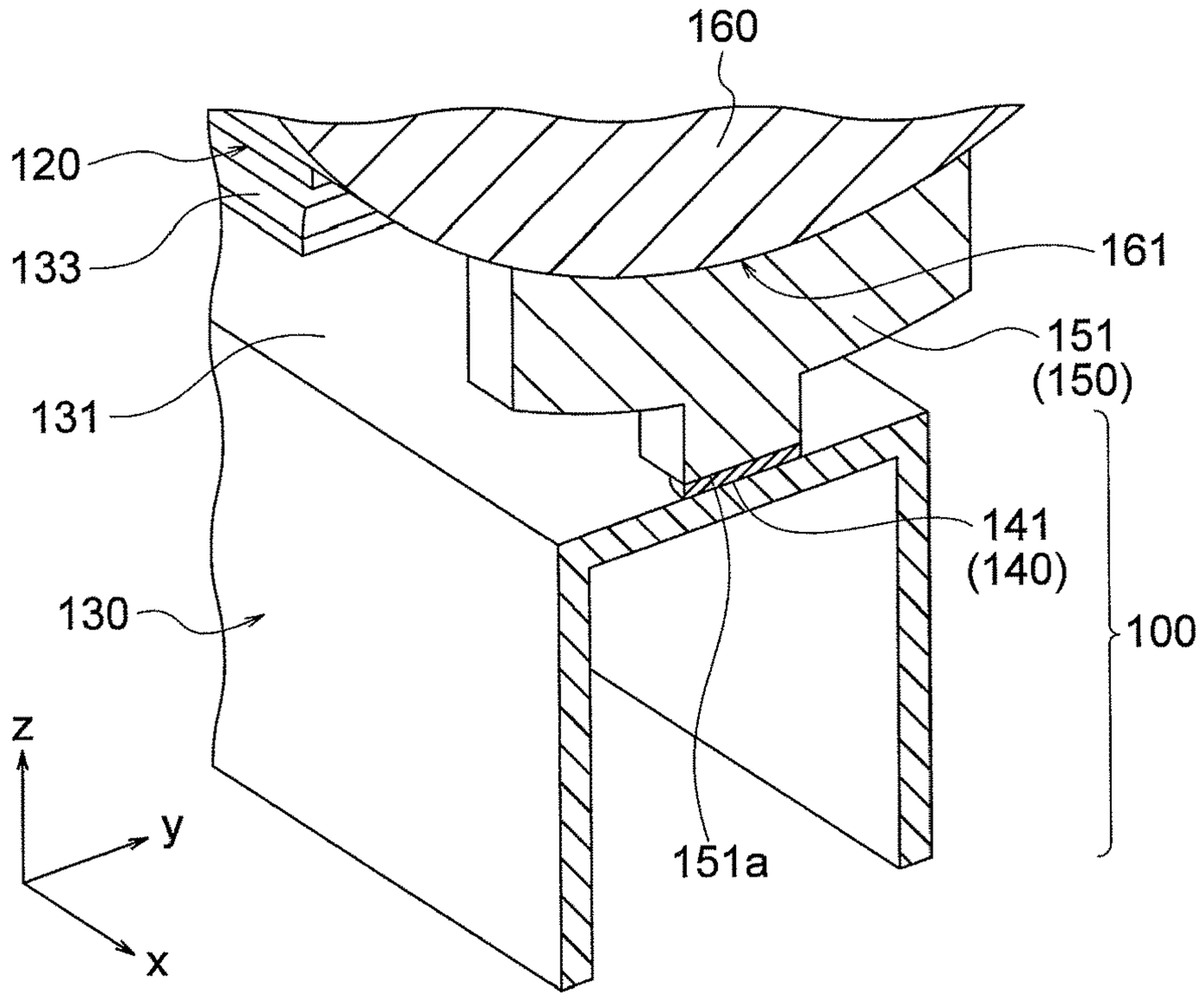
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FIG. 3

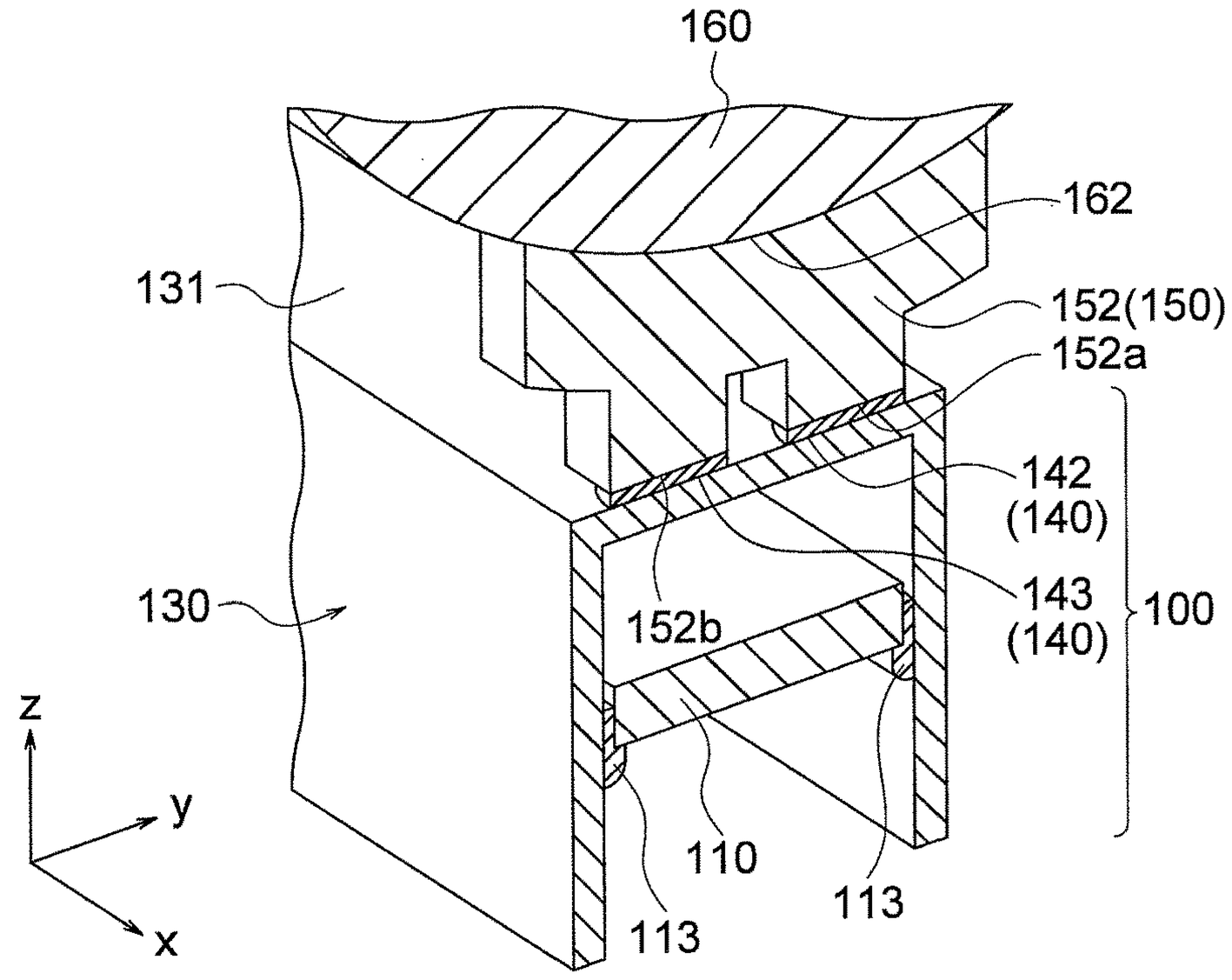
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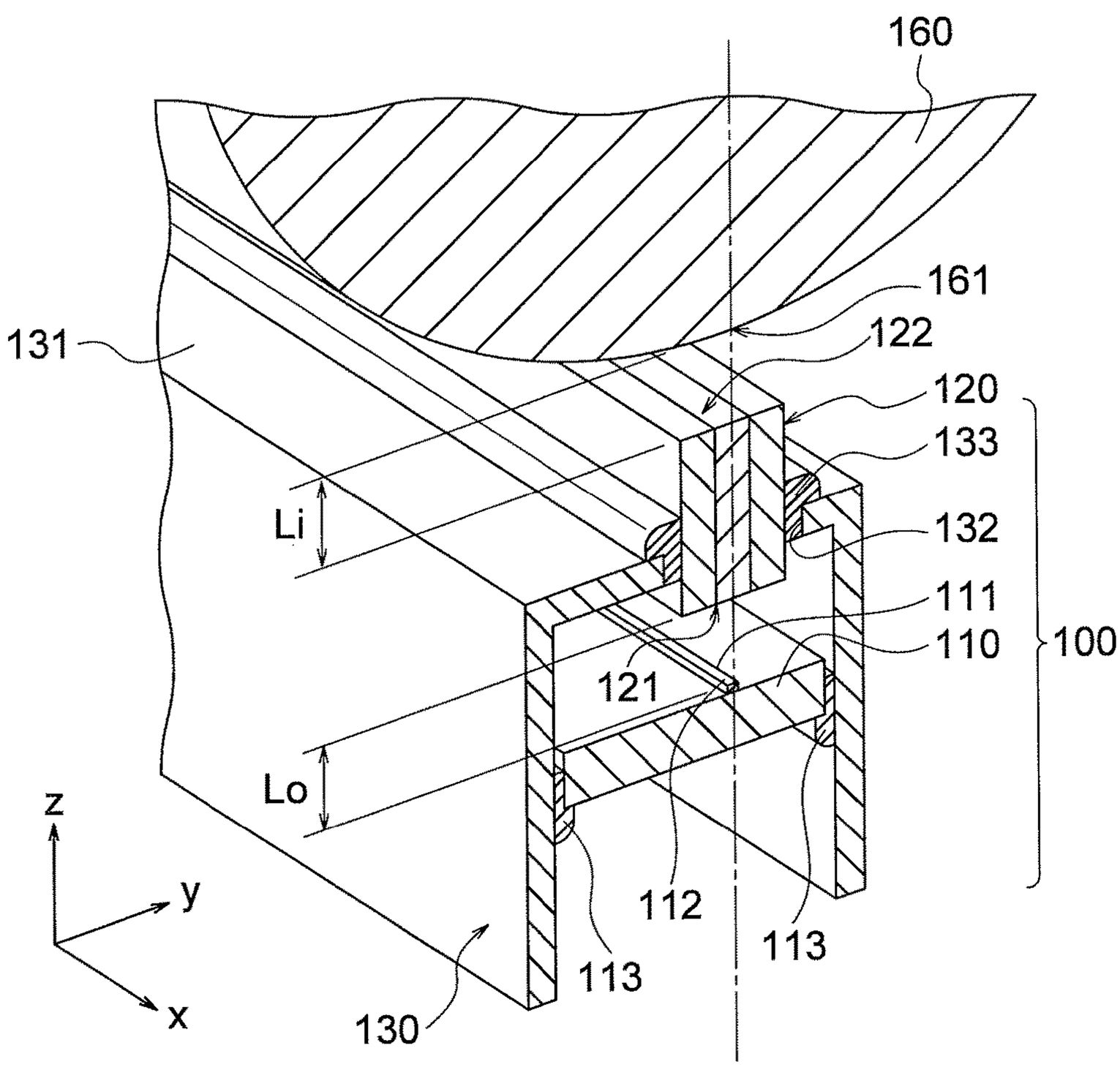
FIG. 4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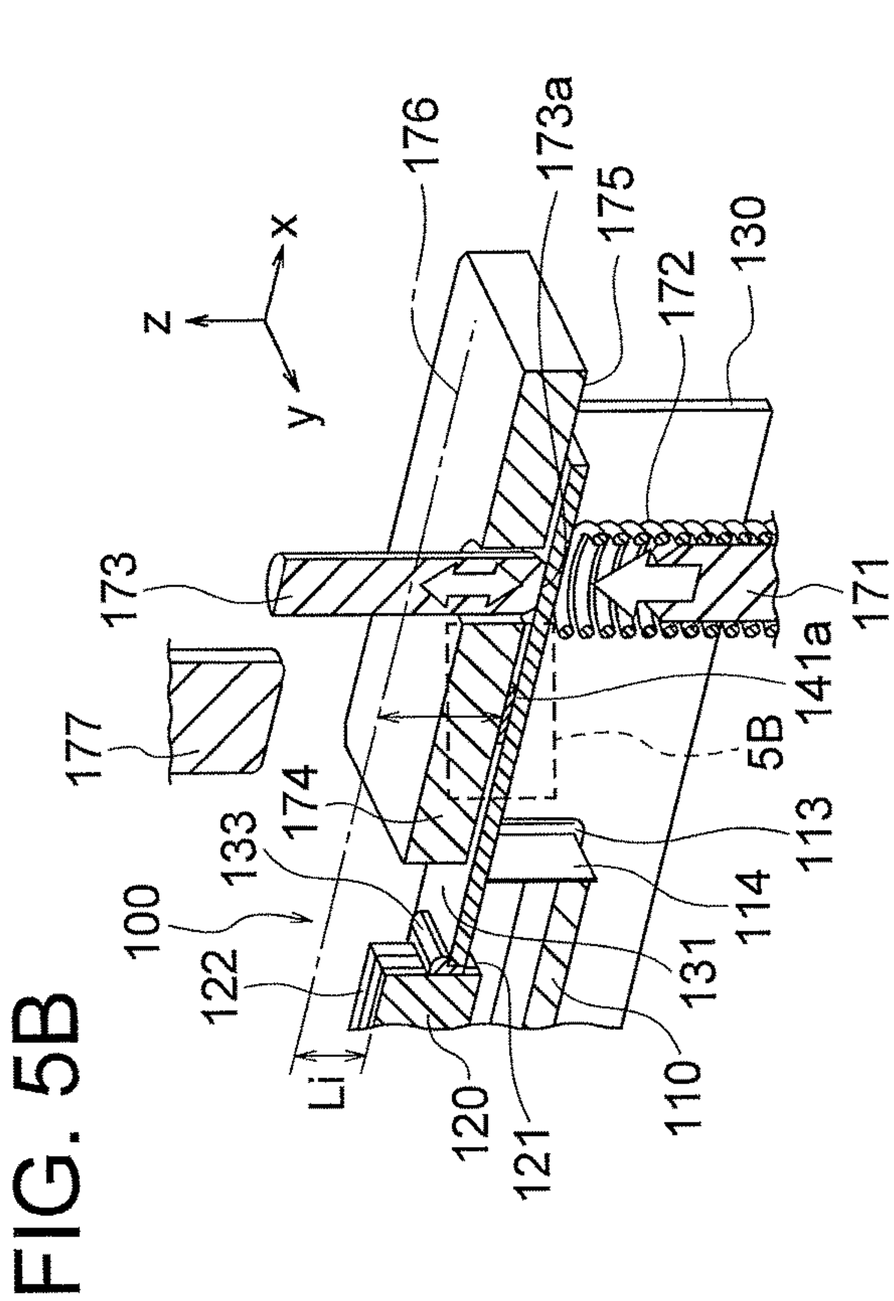


FIG. 5B

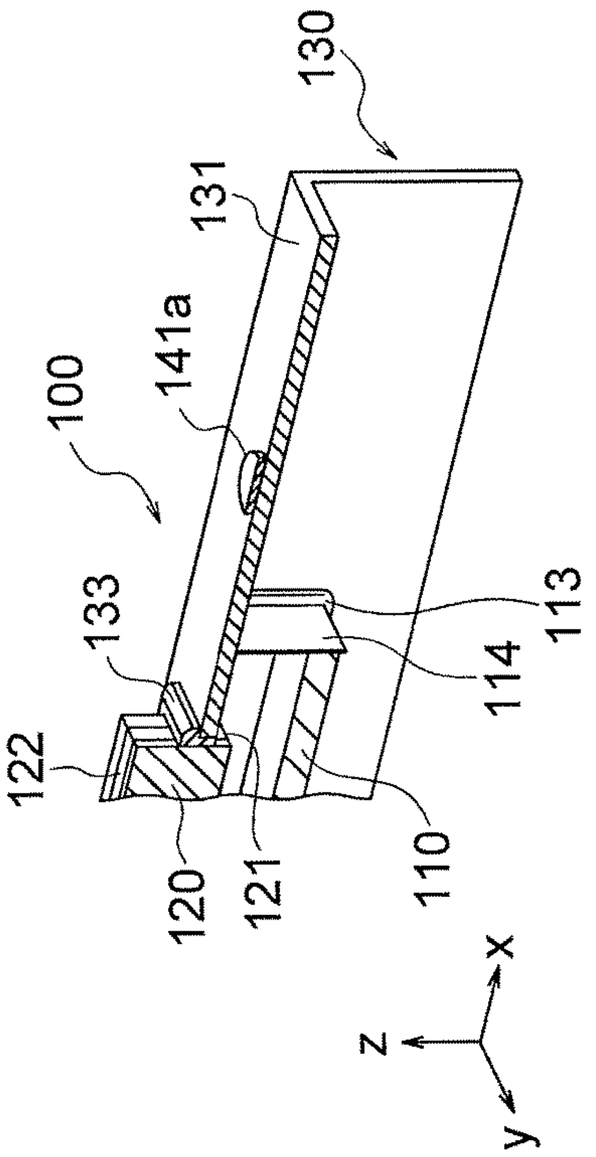


FIG. 5D

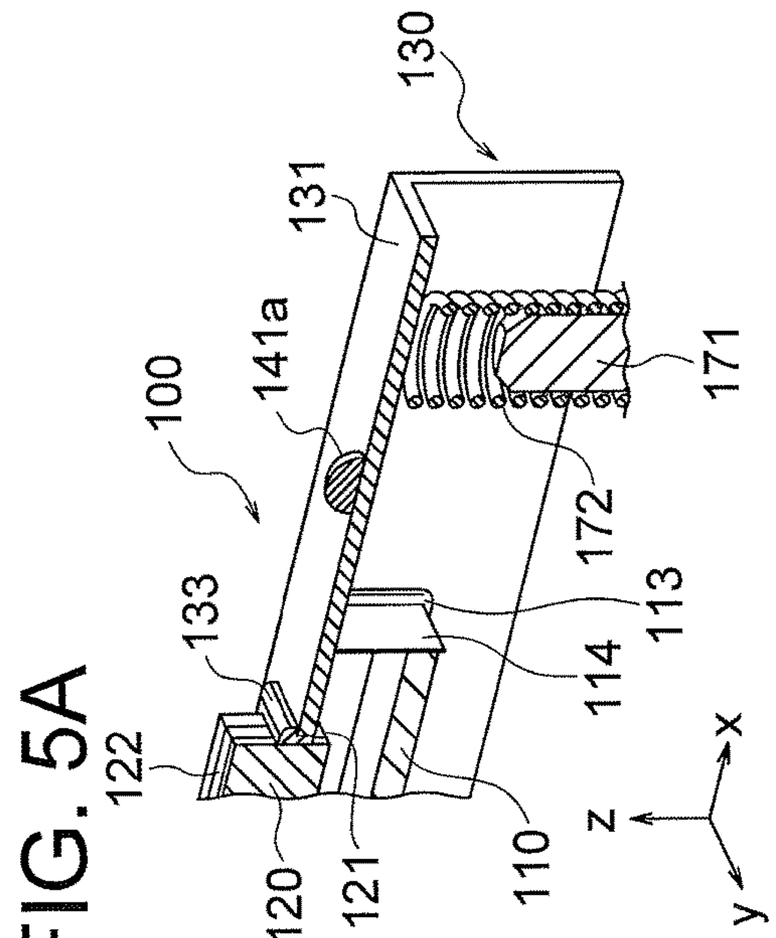


FIG. 5A

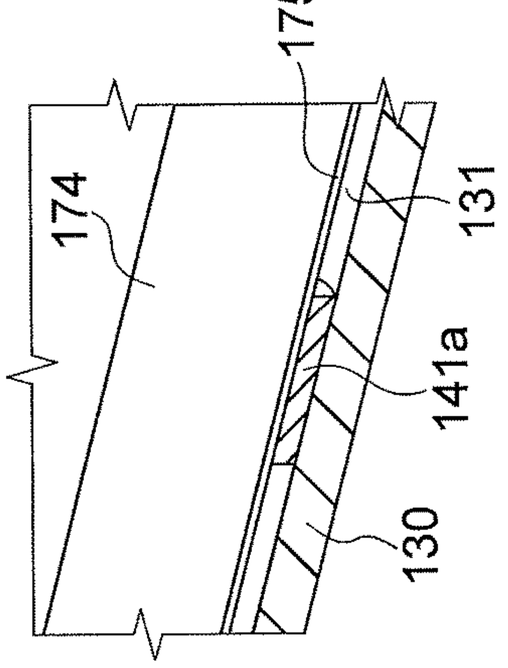


FIG. 5C

FIG. 6C

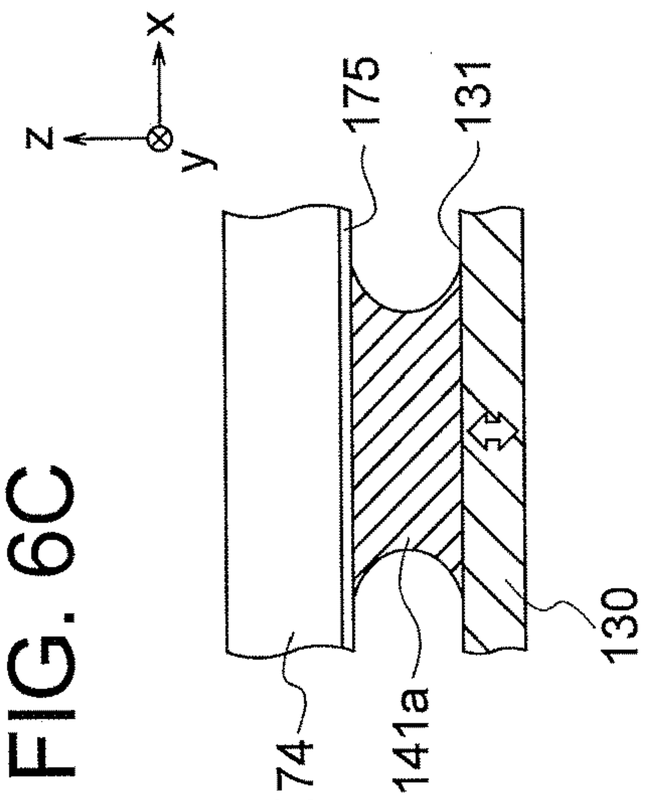


FIG. 6B

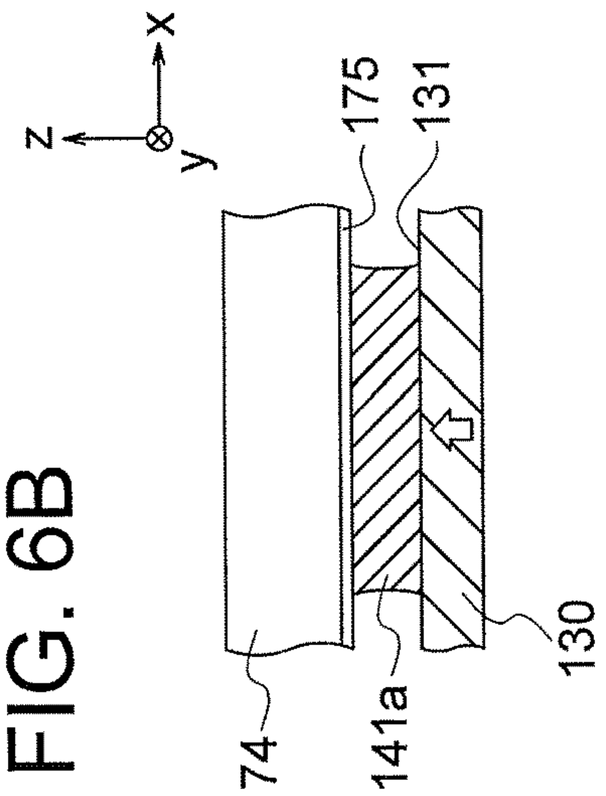


FIG. 6E

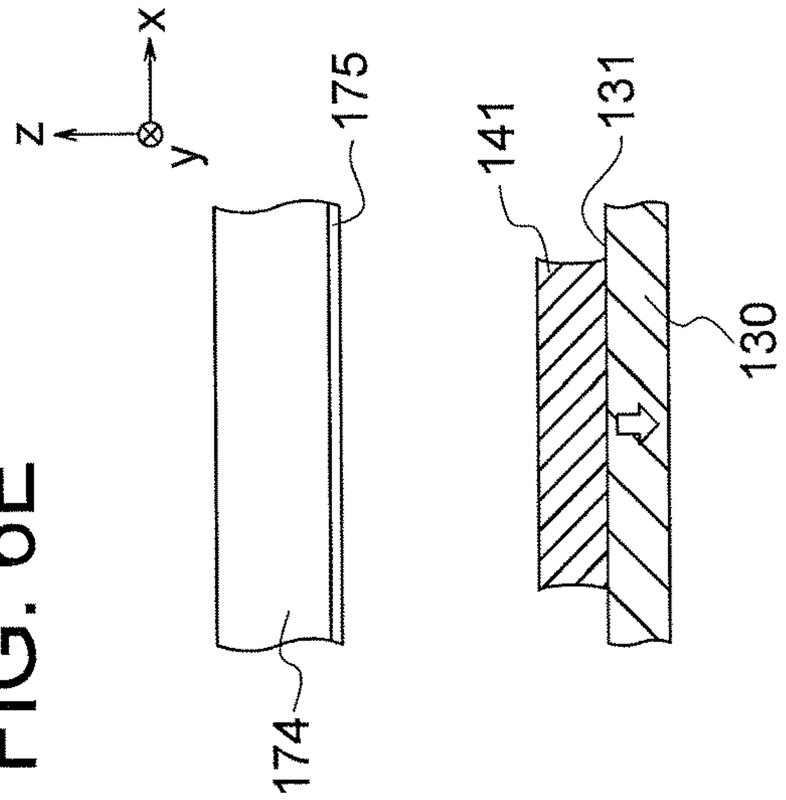


FIG. 6A

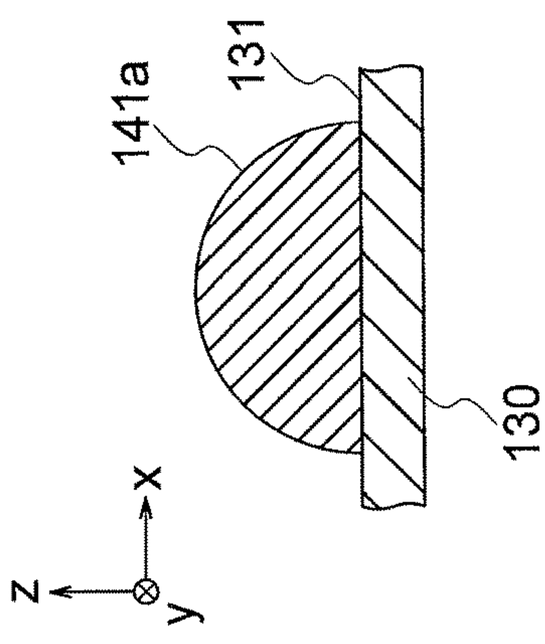
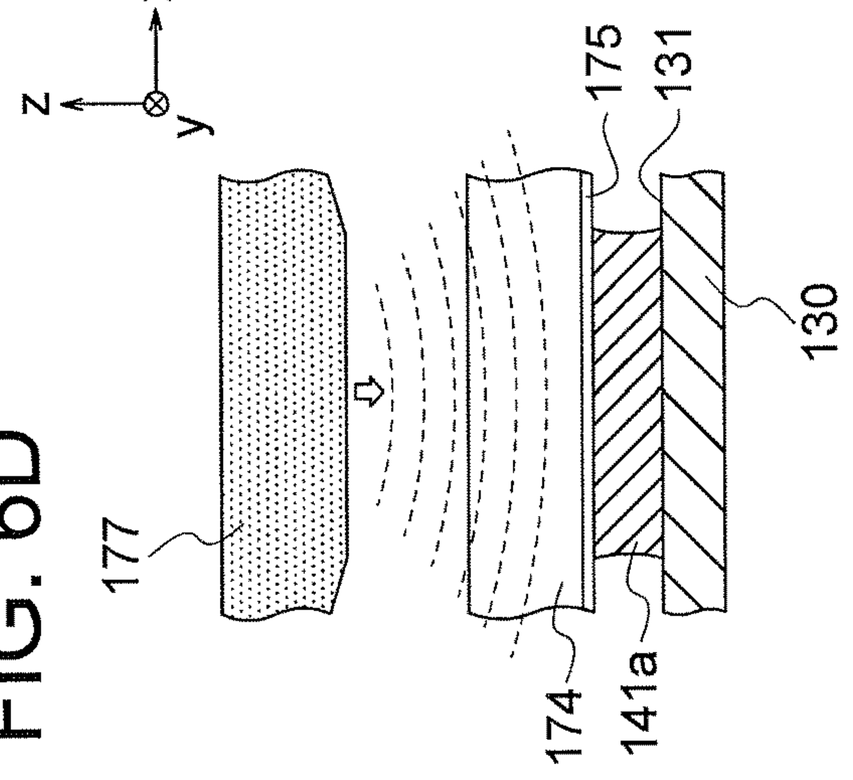


FIG. 6D



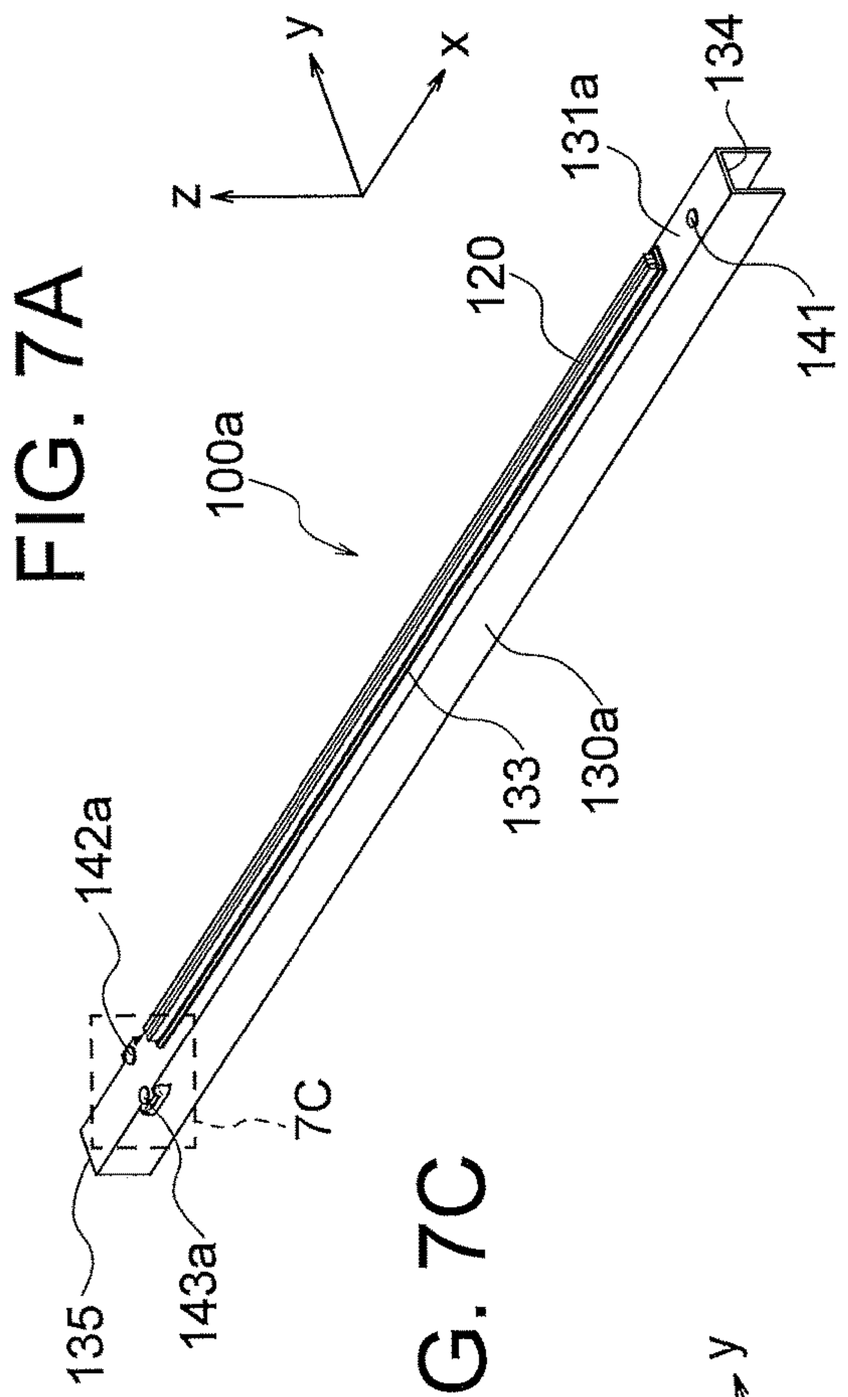


FIG. 7A

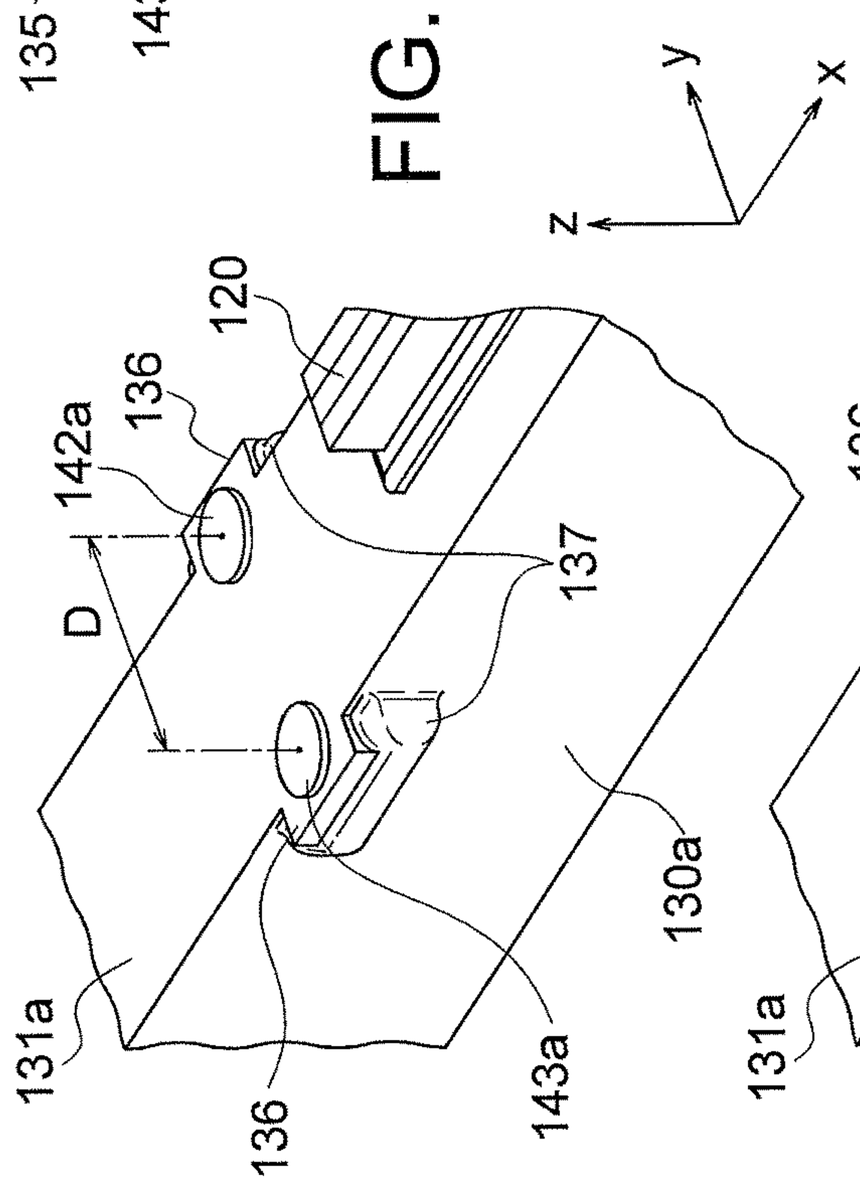


FIG. 7C

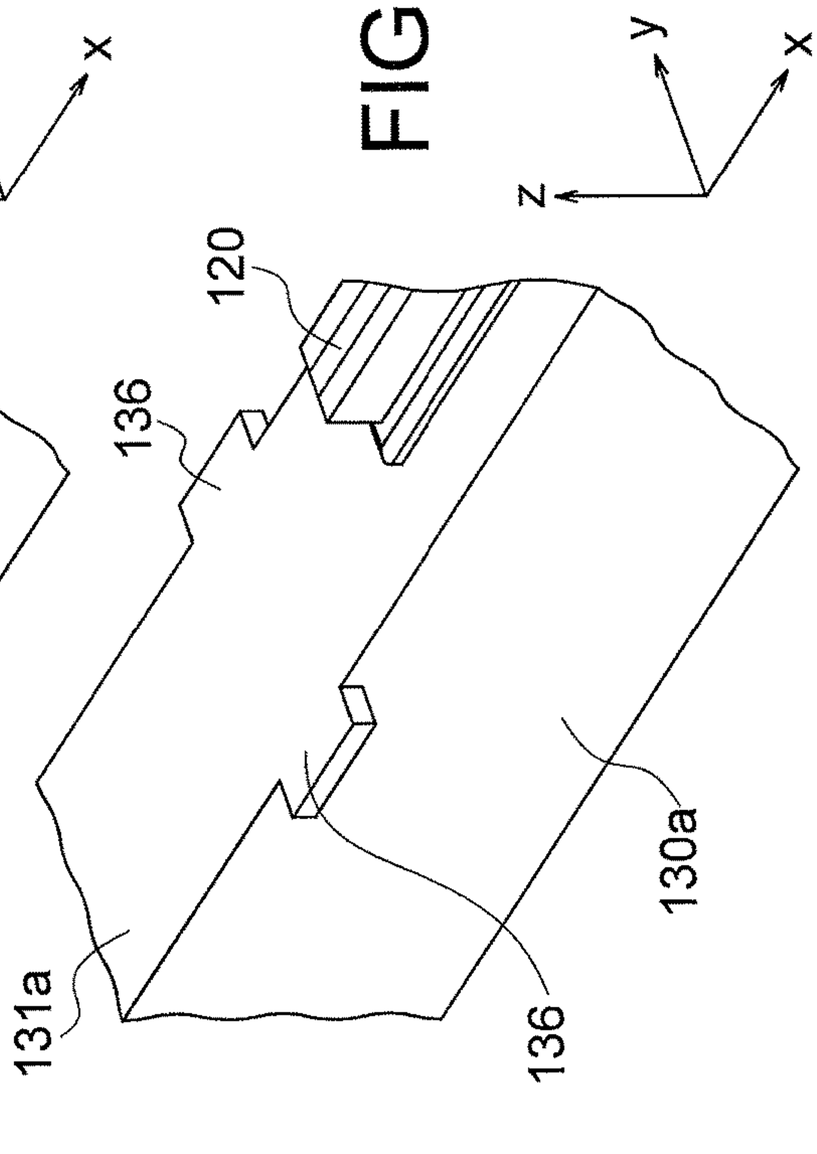
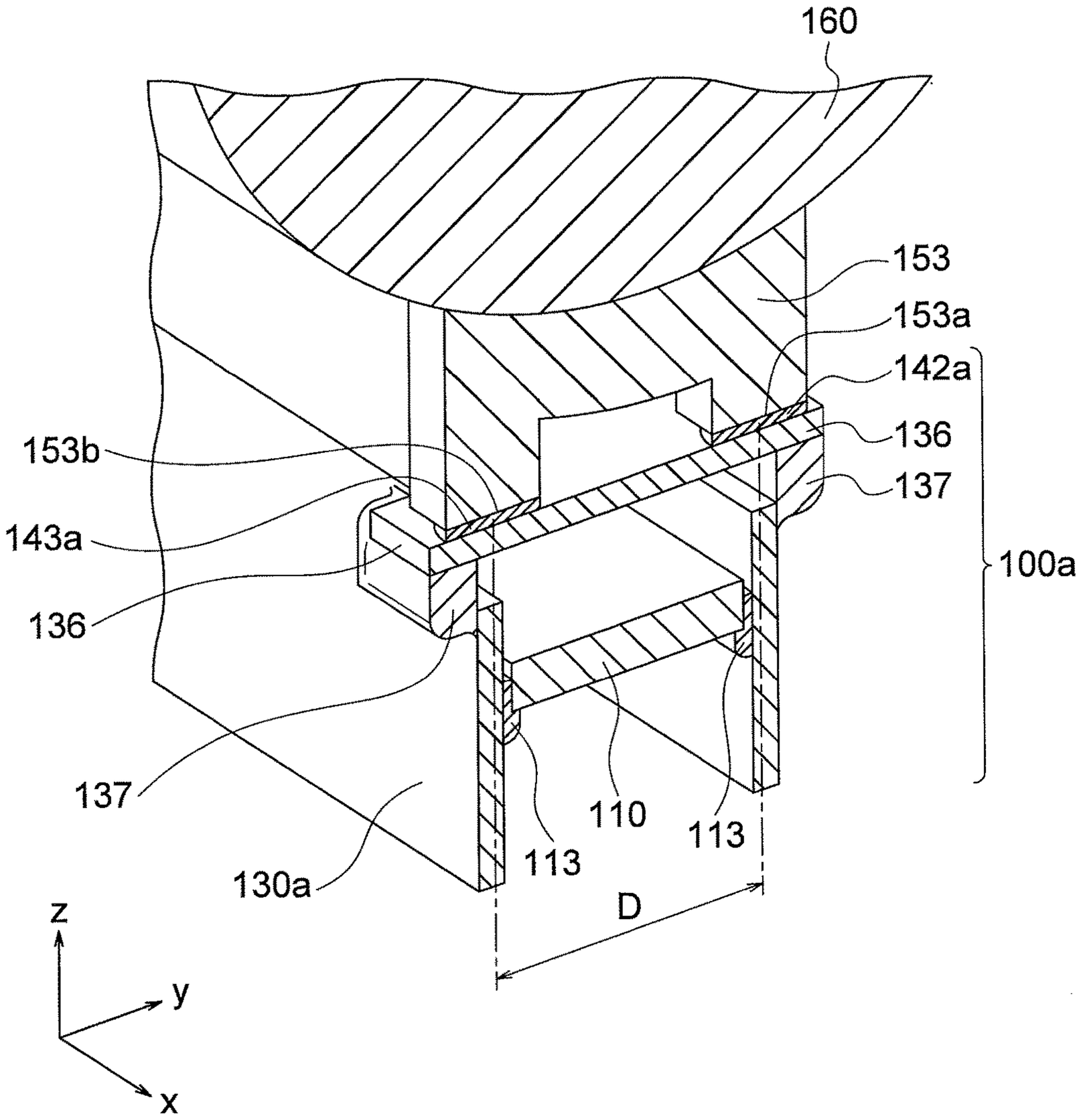


FIG. 7B

FIG. 8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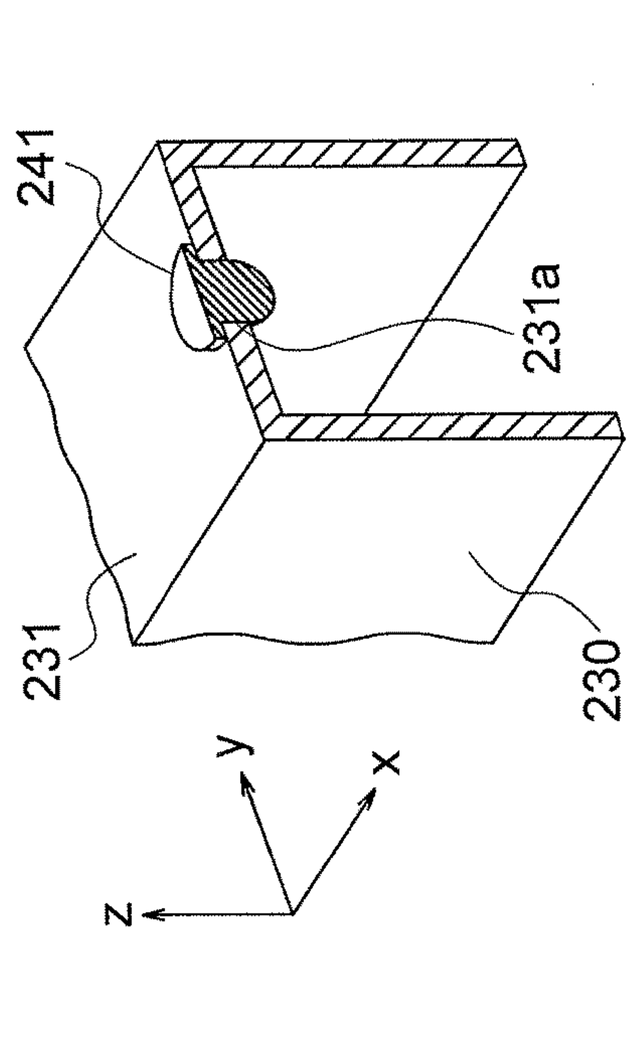


FIG. 9B

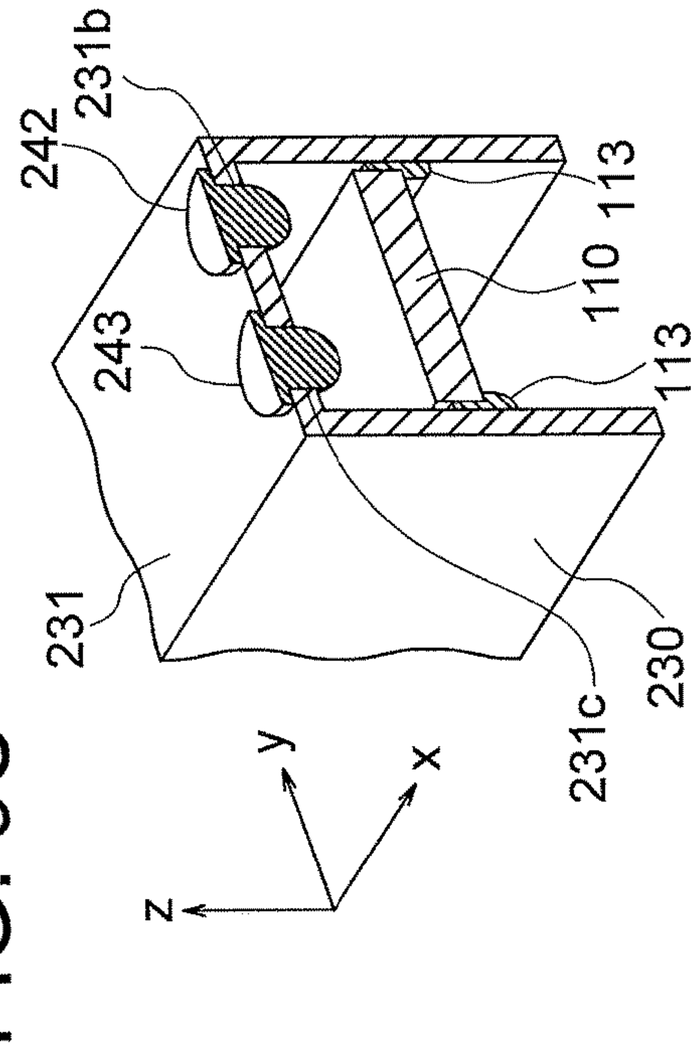
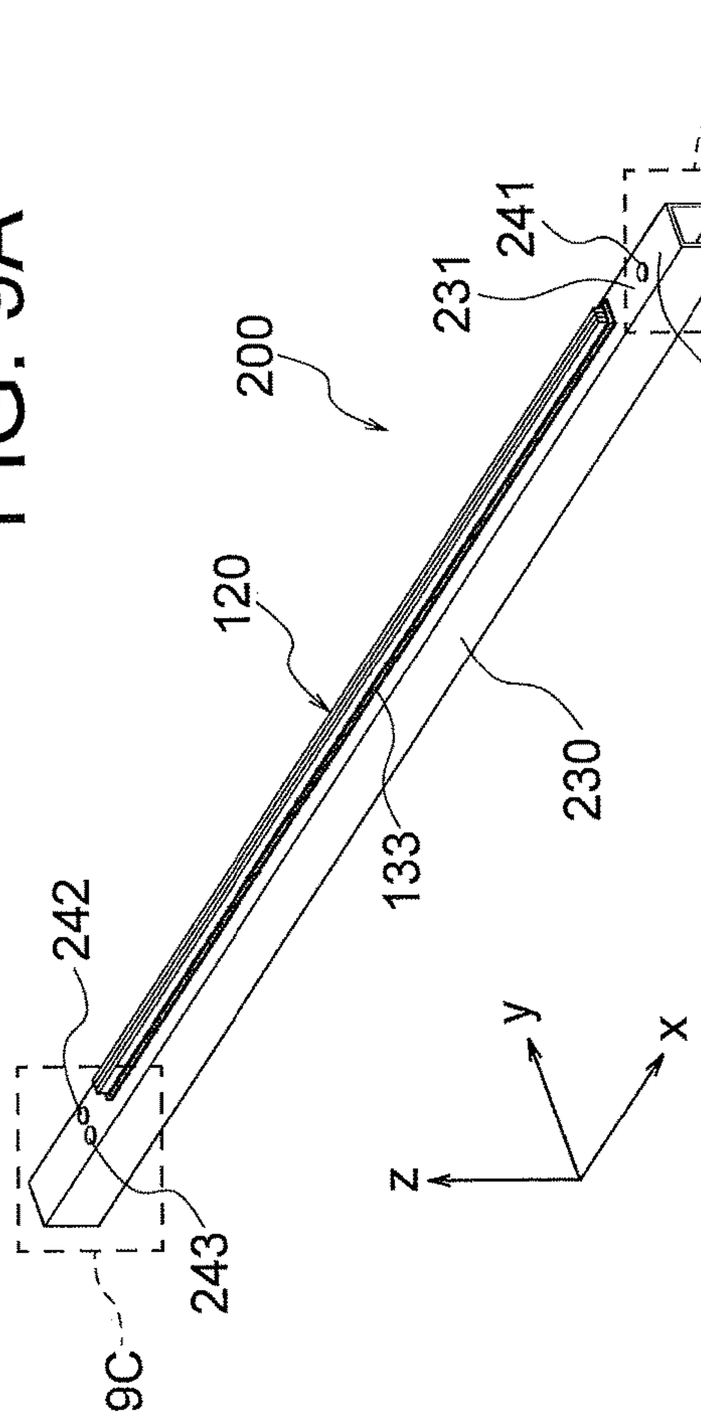


FIG. 9C

FIG. 9A



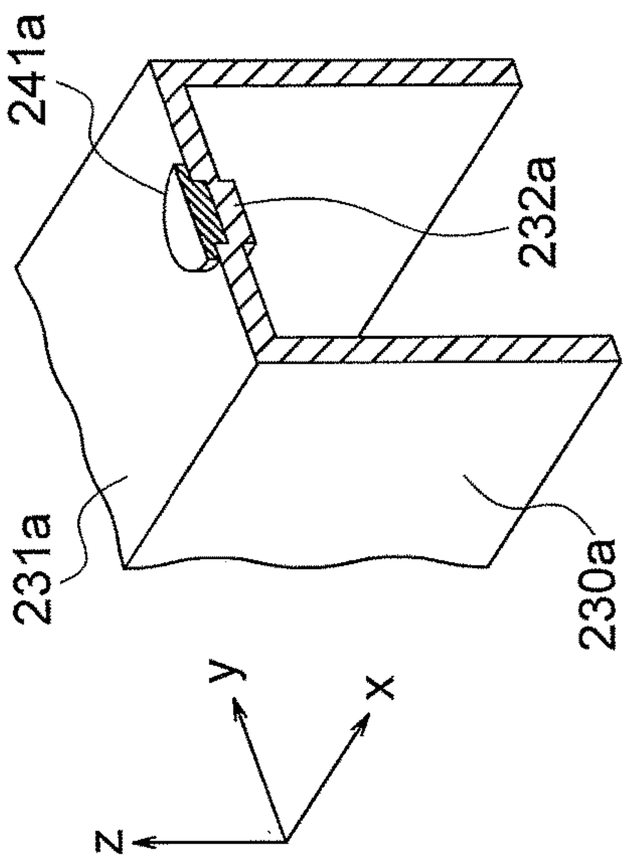


FIG. 10B

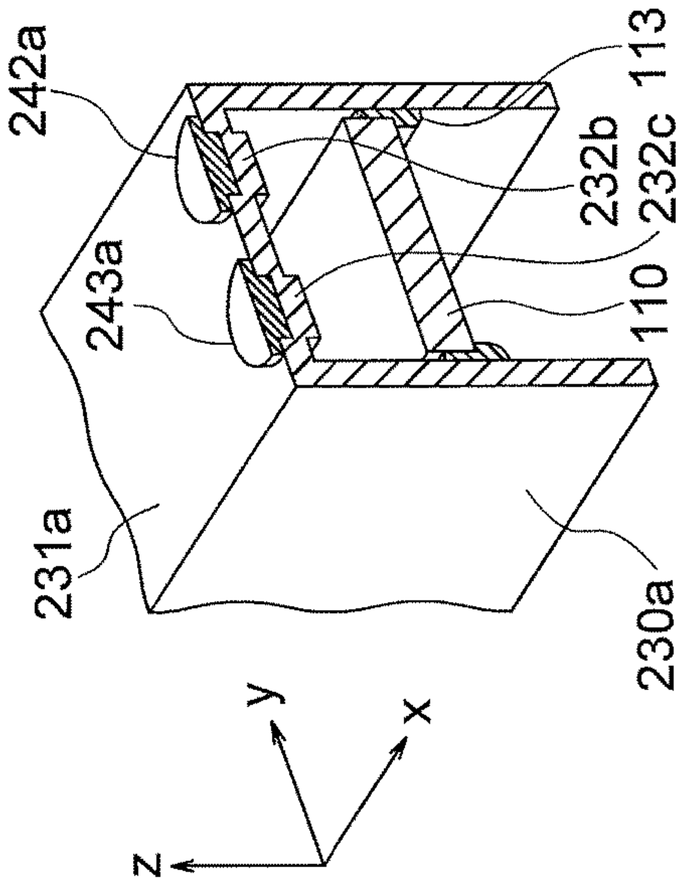


FIG. 10C

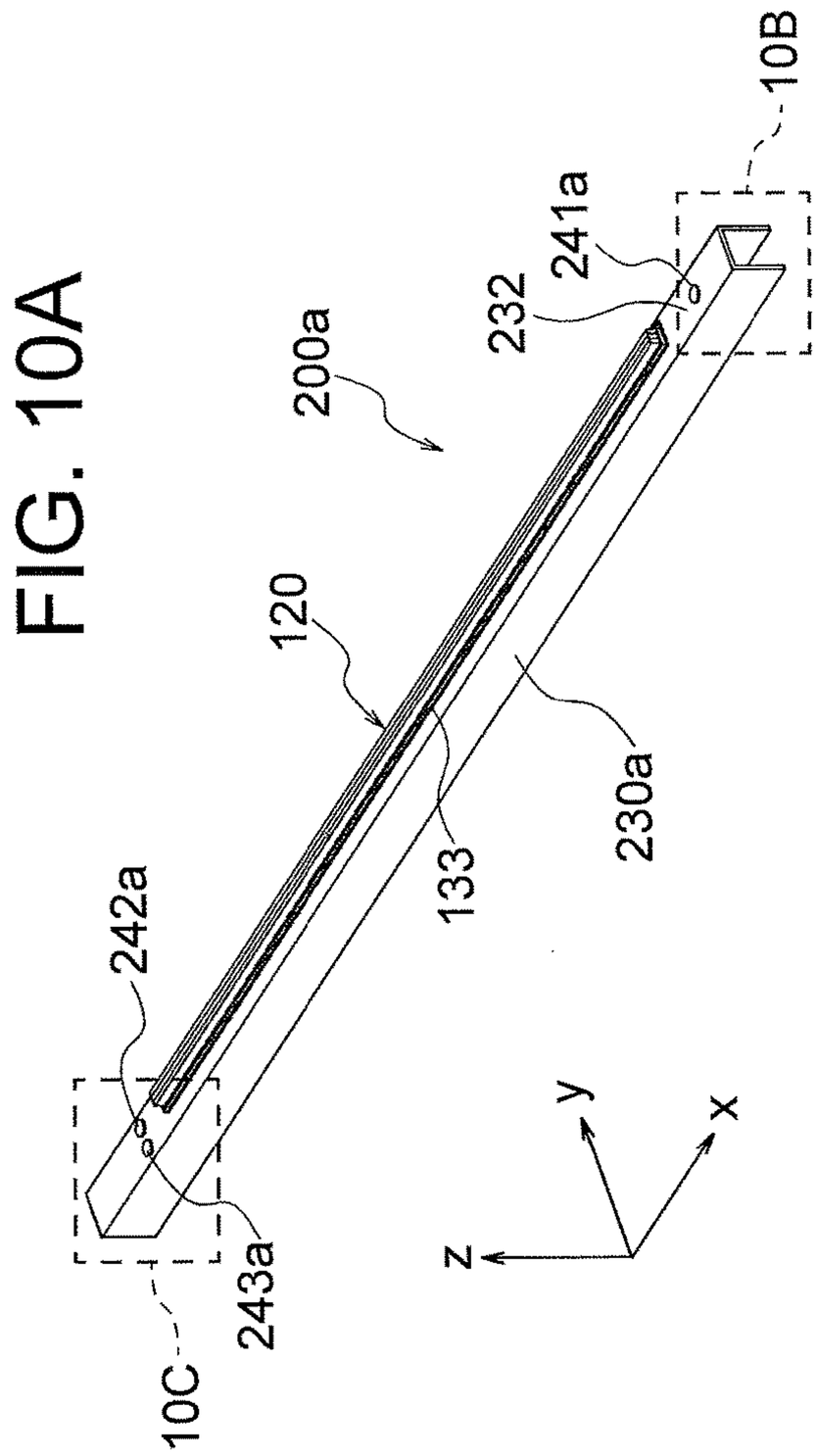


FIG. 10A

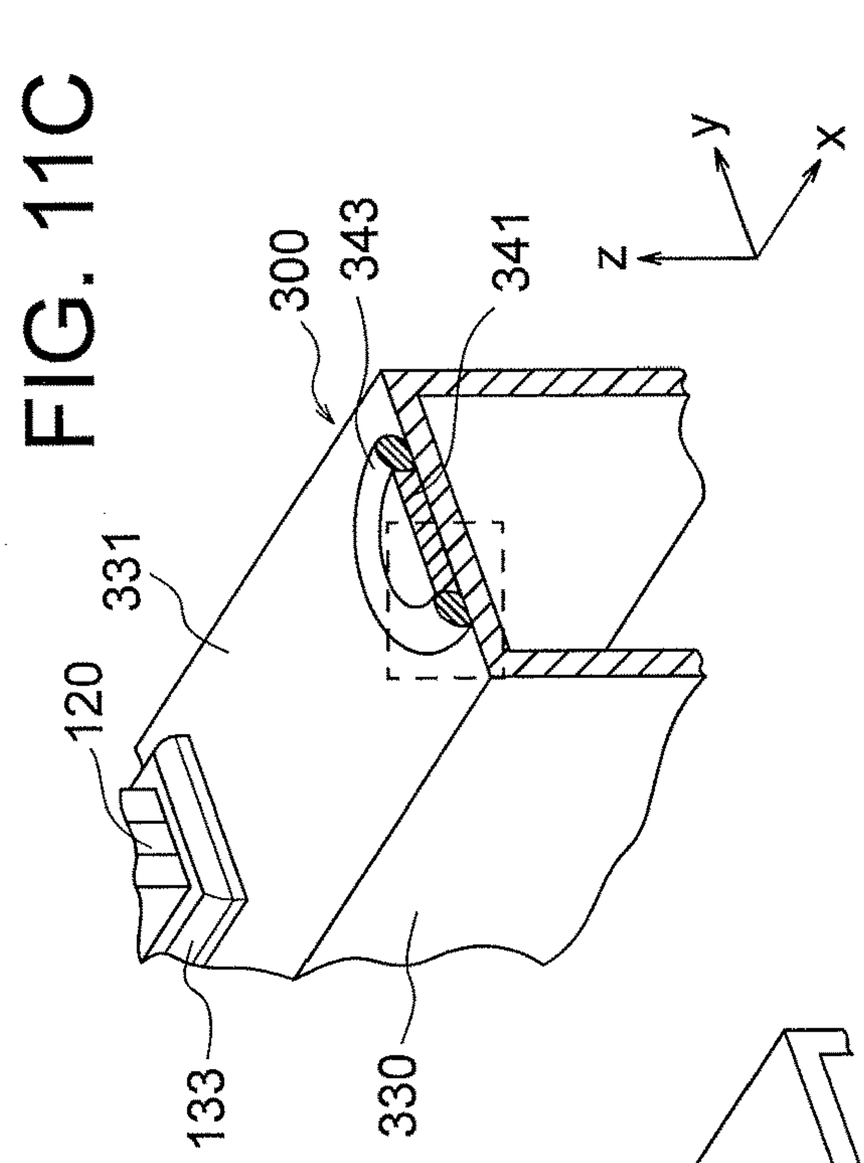


FIG. 11C

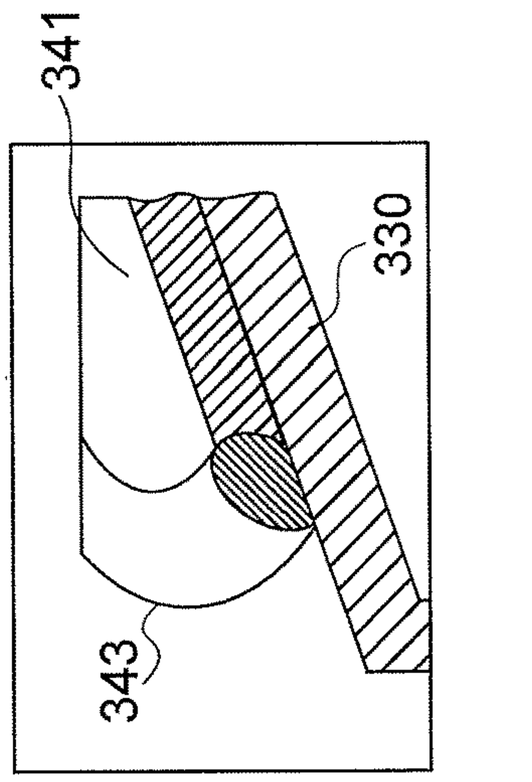


FIG. 11D

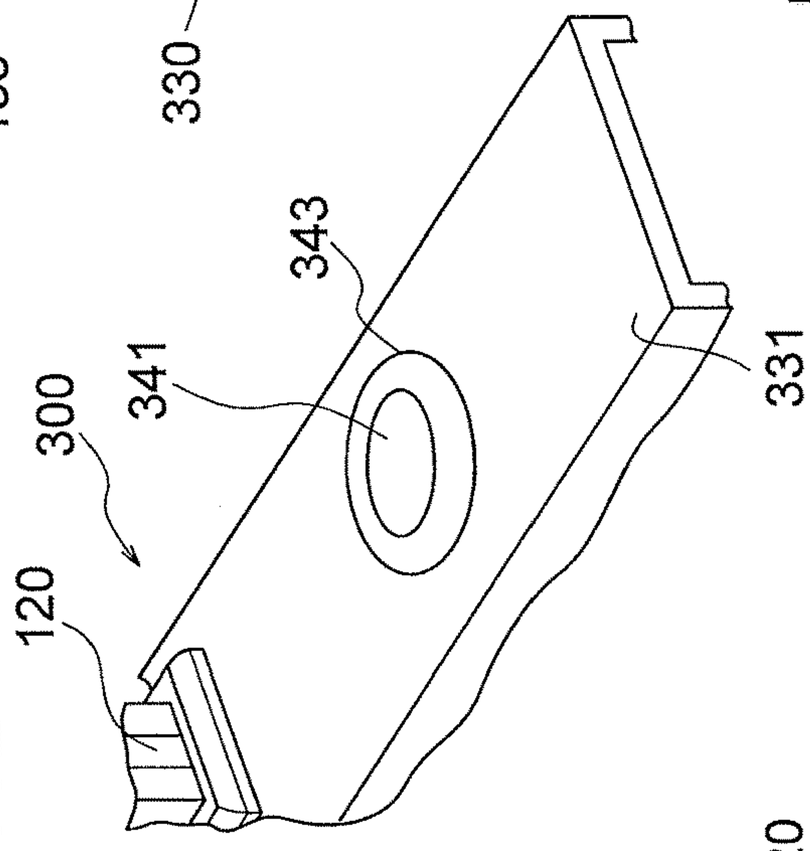


FIG. 11B

FIG. 11A

FIG. 12A

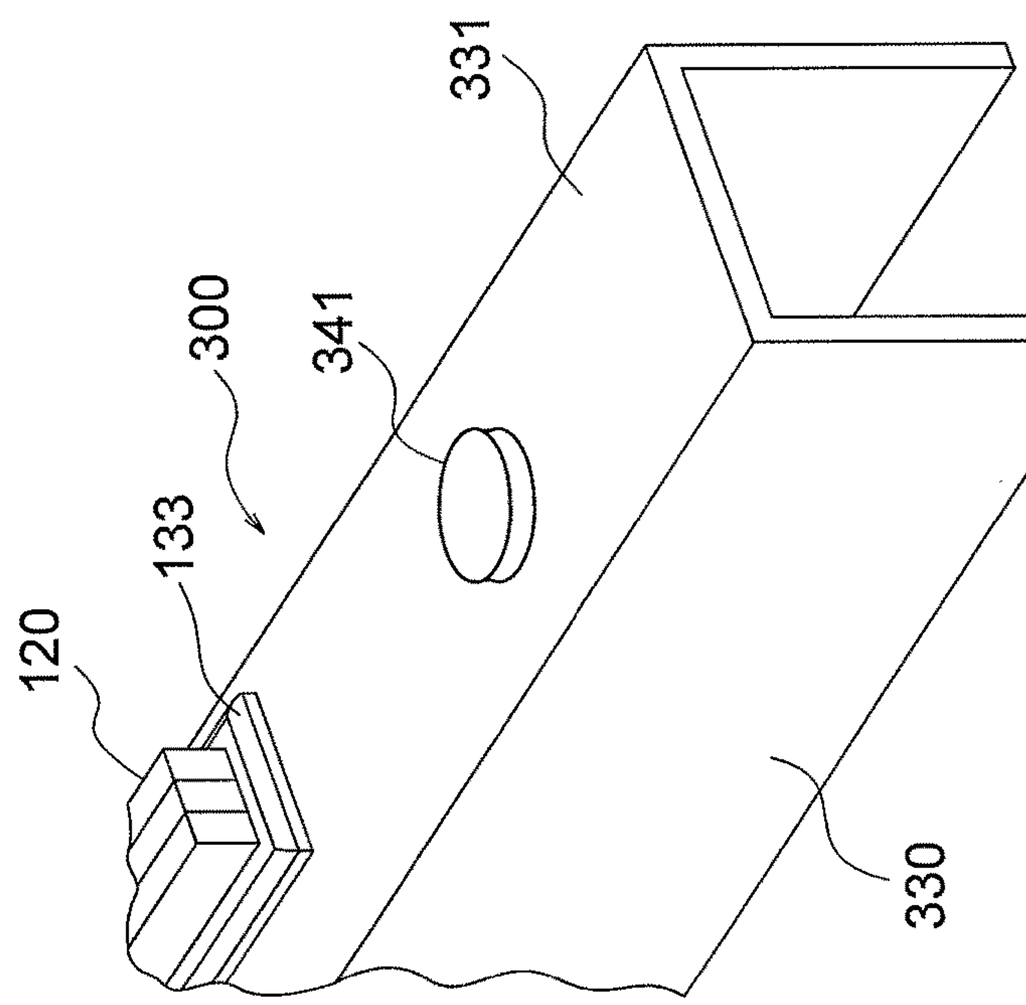
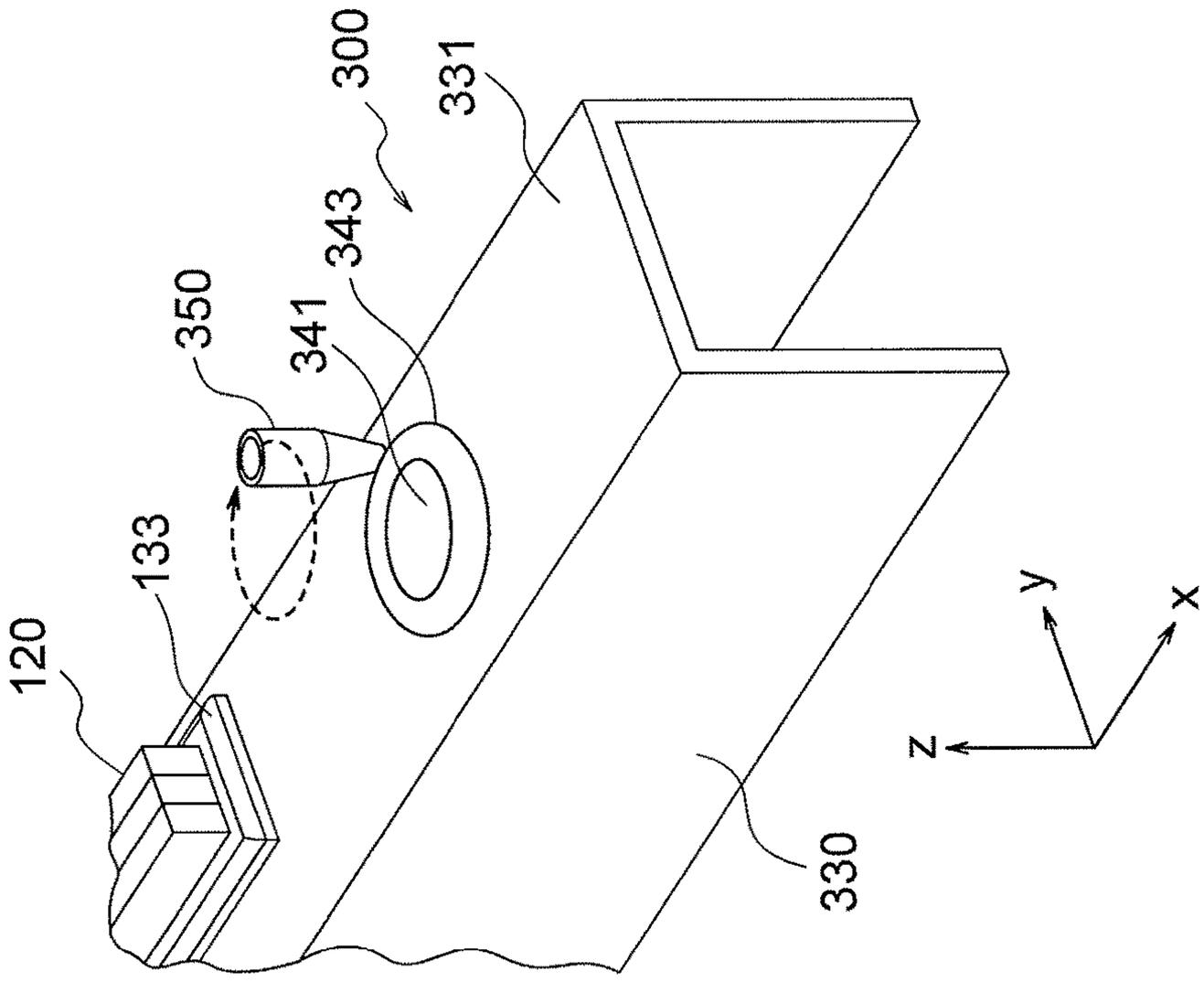
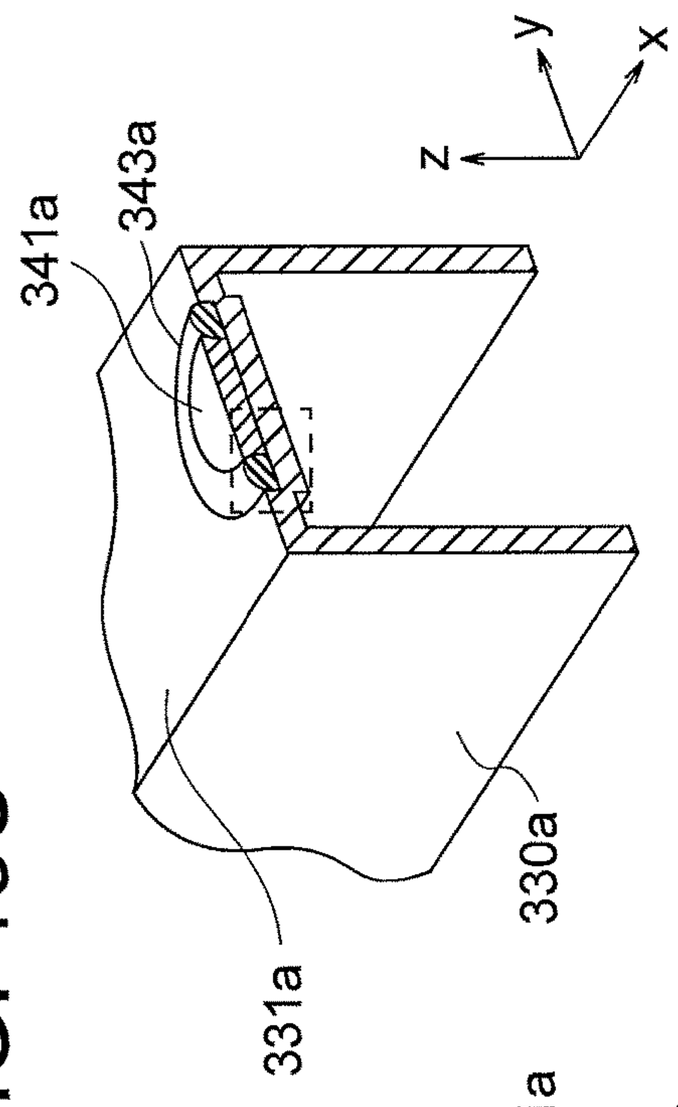


FIG. 12B





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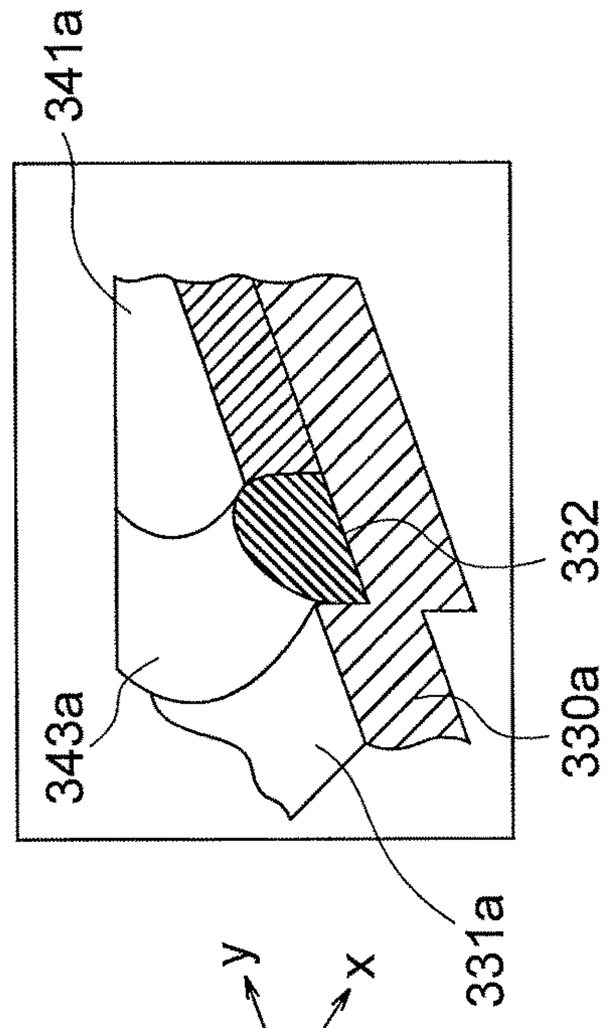

FIG. 13D

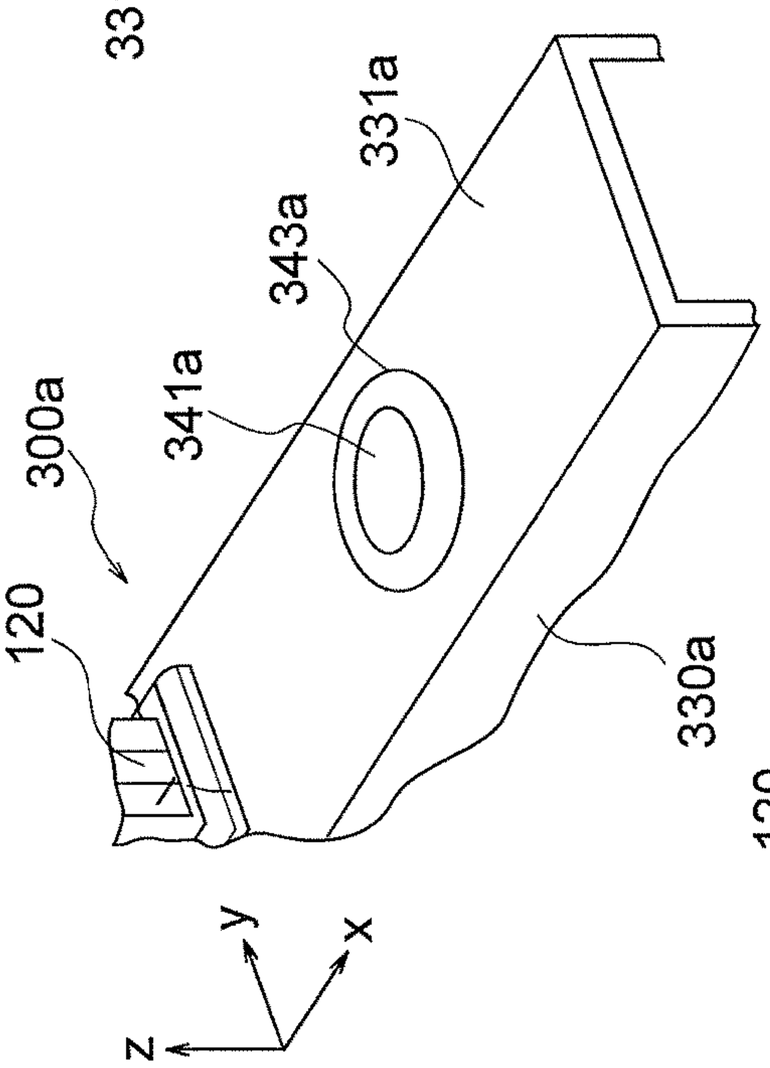

FIG. 13B

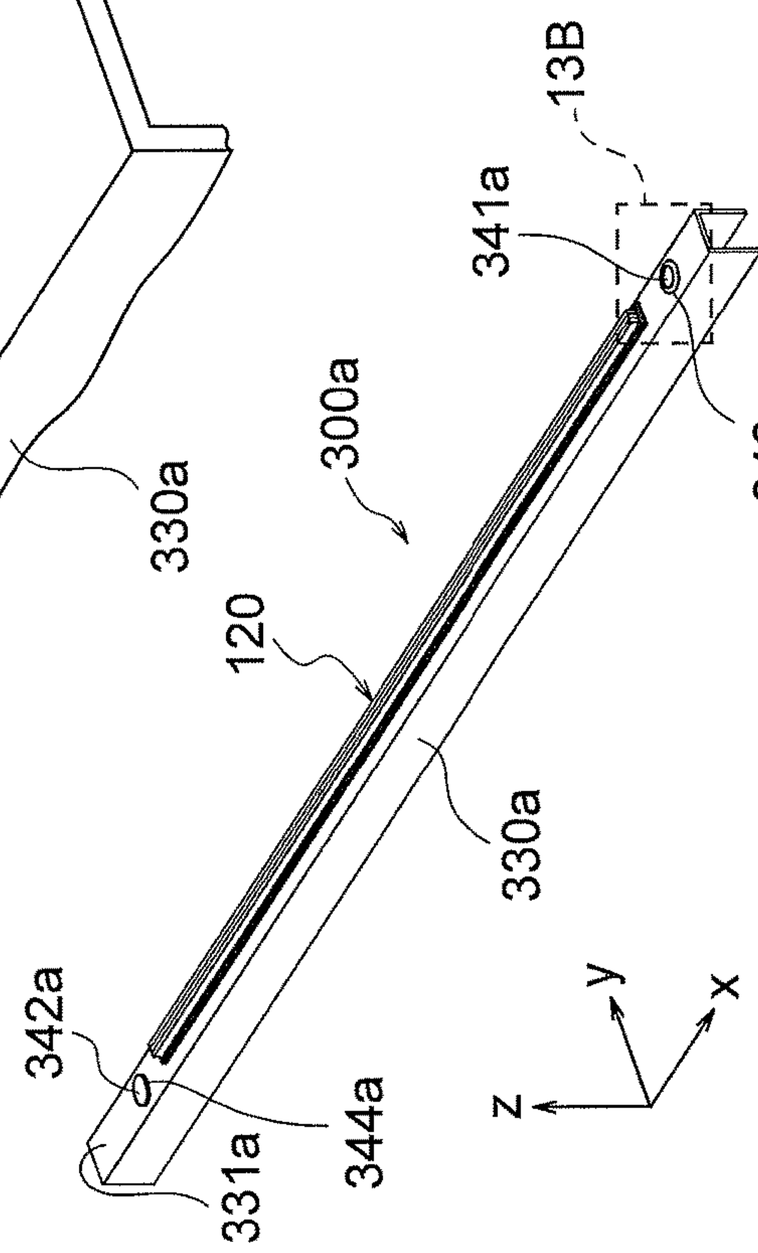

FIG. 13A

FIG. 14A

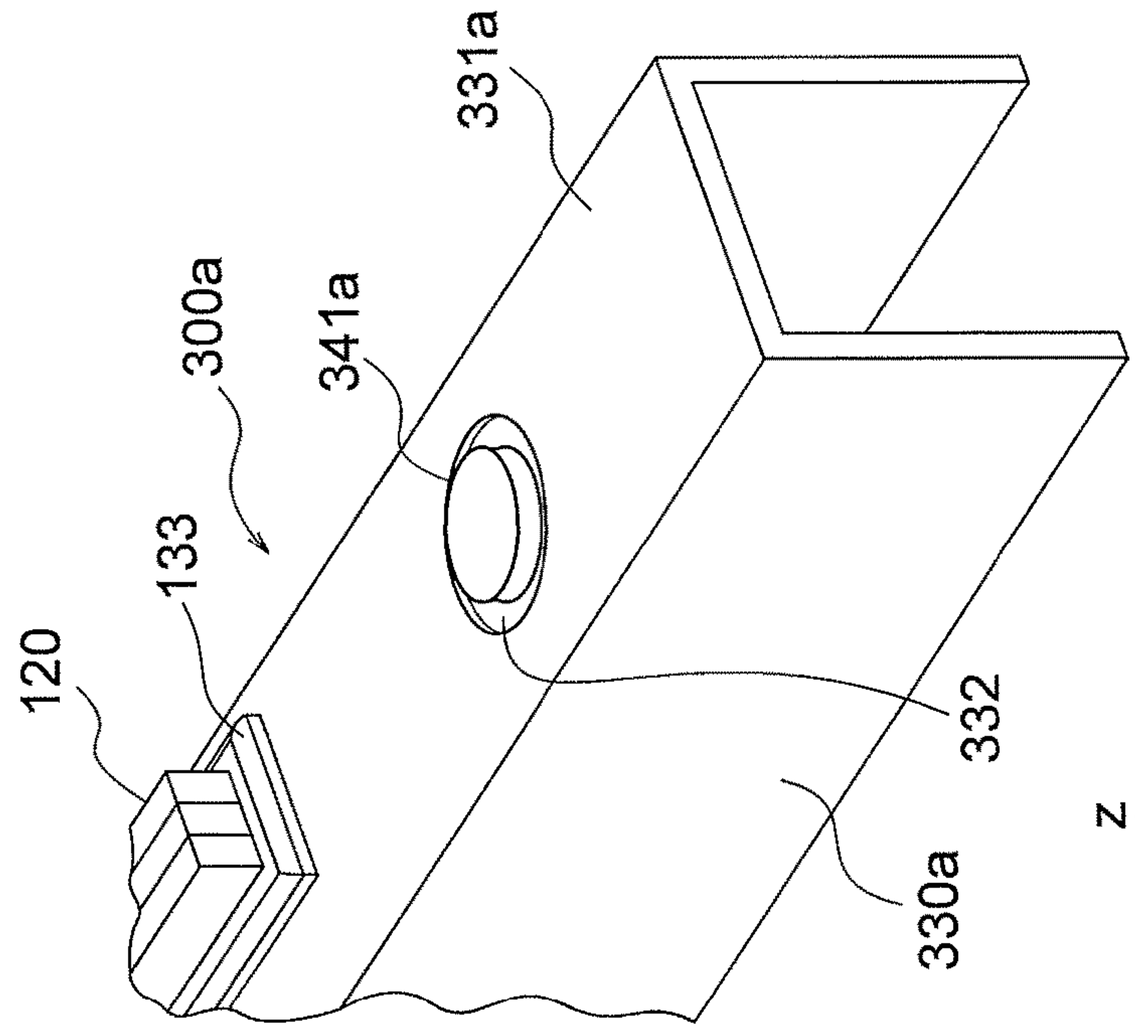

FIG. 14B

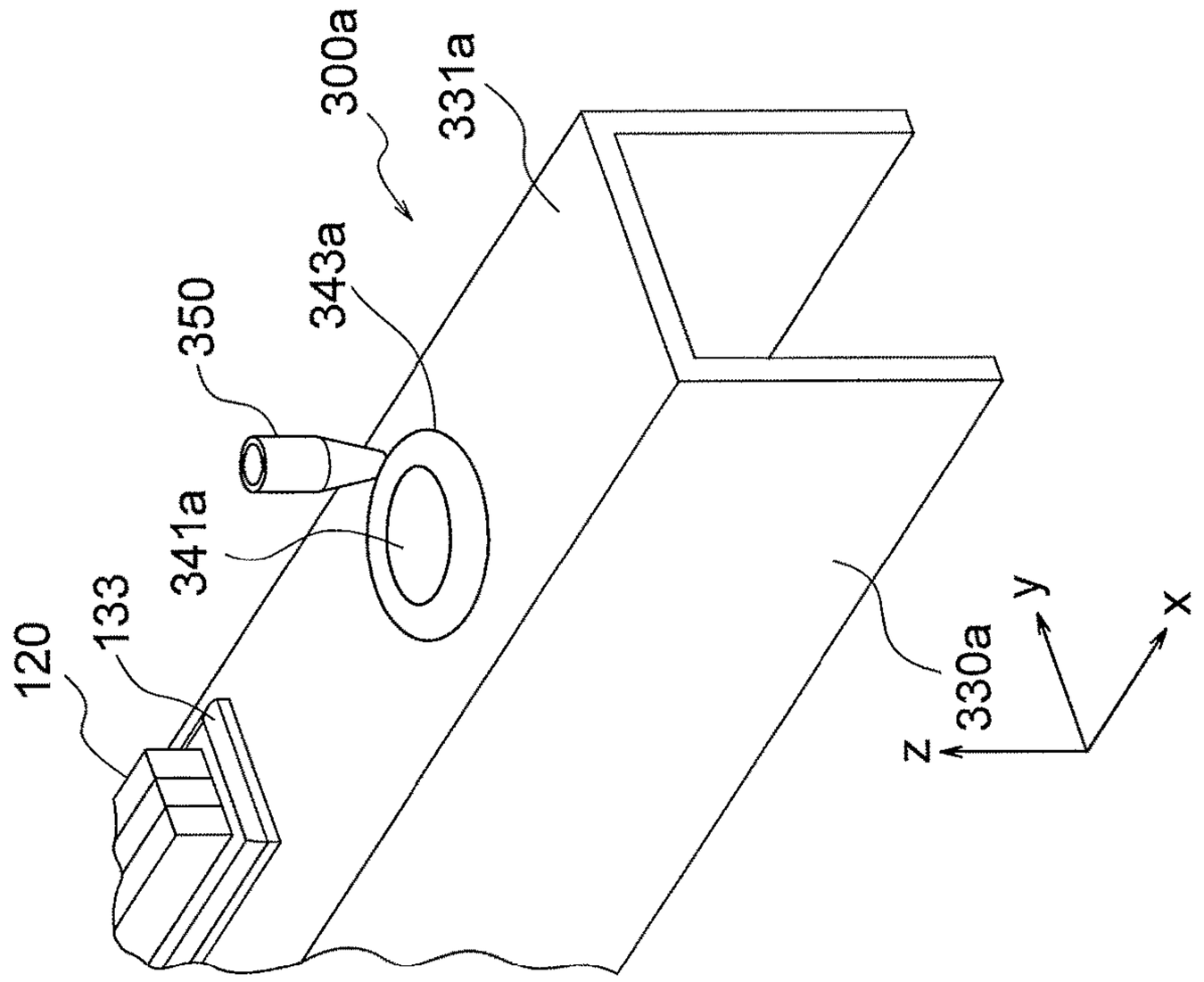

FIG. 15

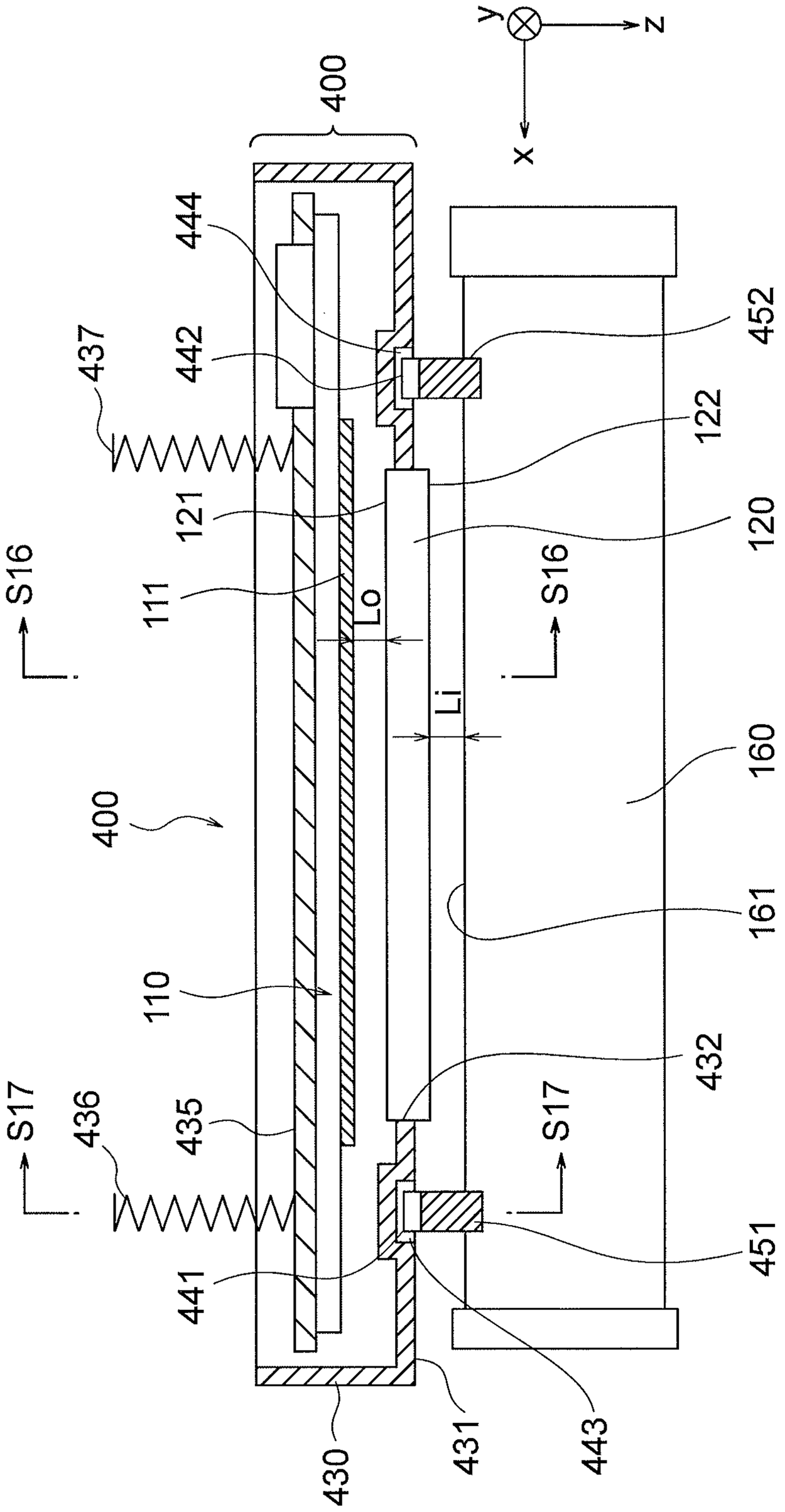
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FIG. 16

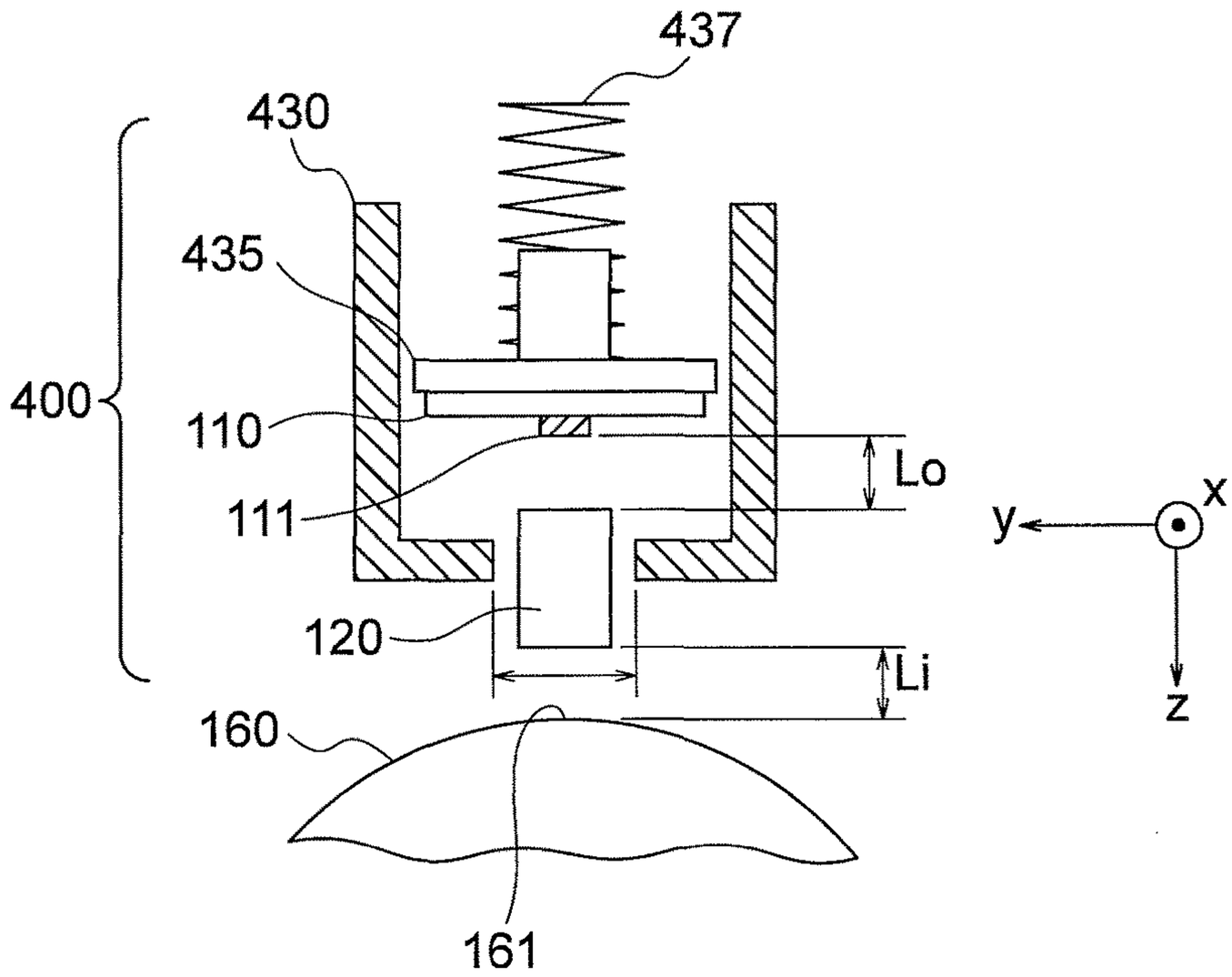
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FIG. 17

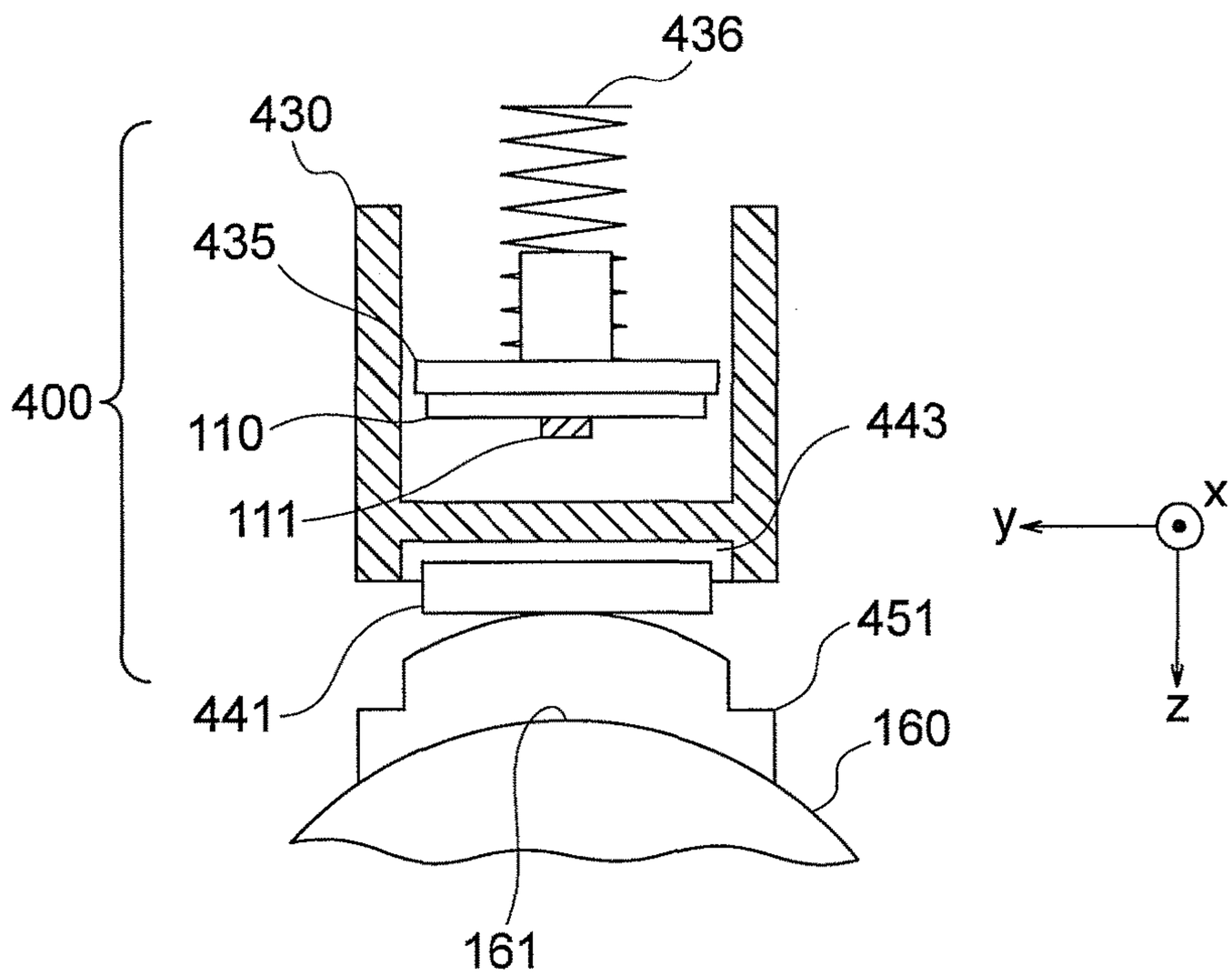
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FIG. 18

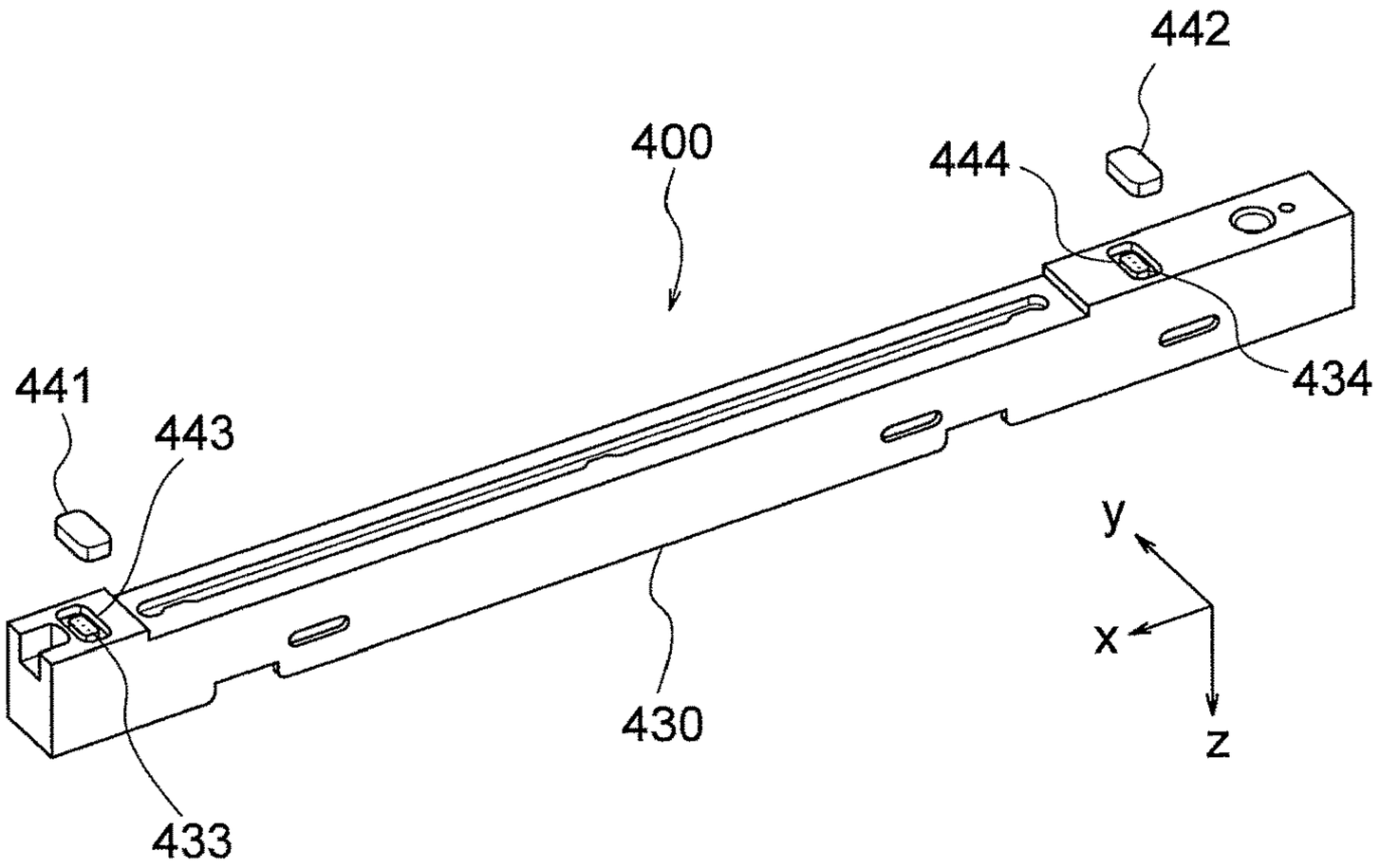
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FIG. 19

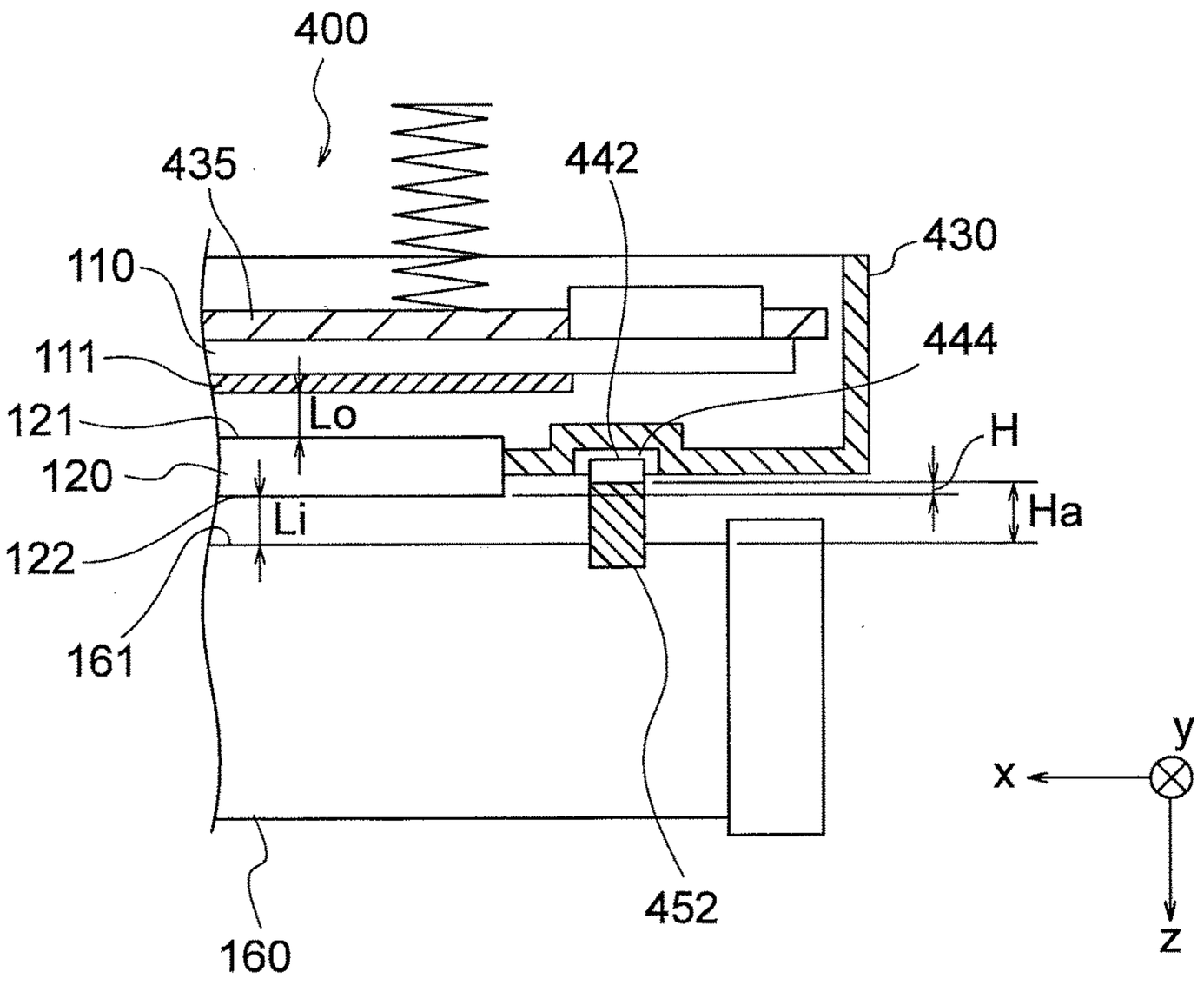
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FIG. 20A

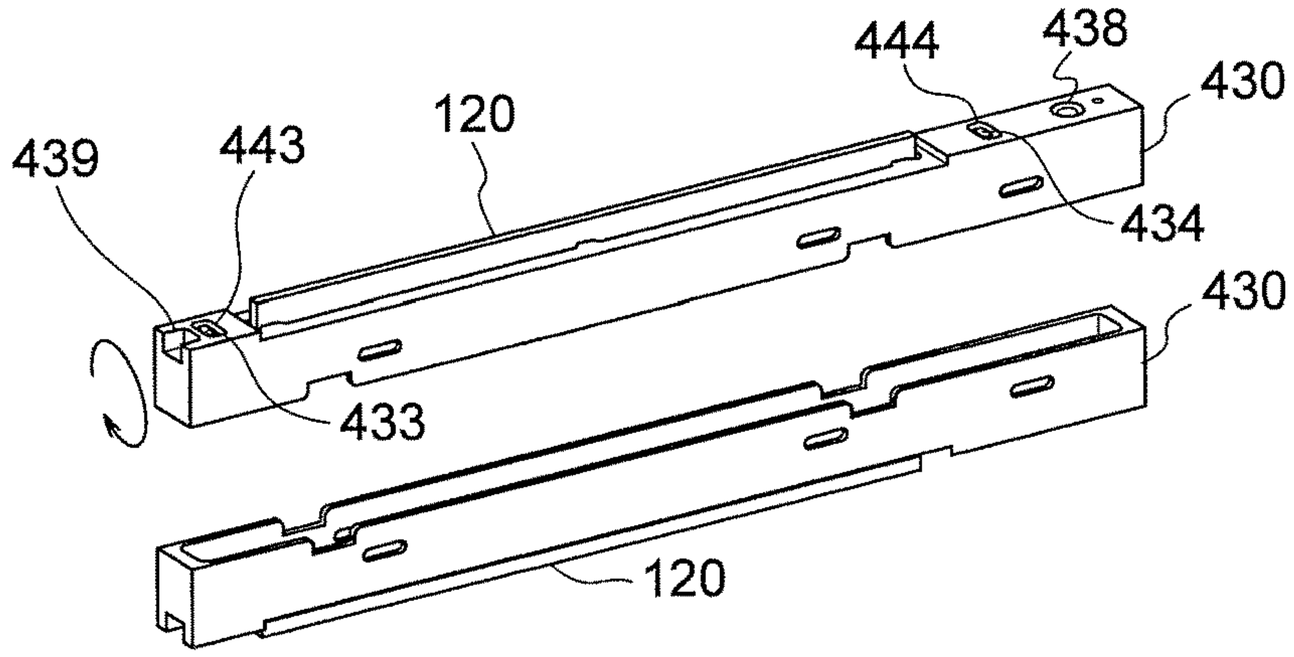

FIG. 20B

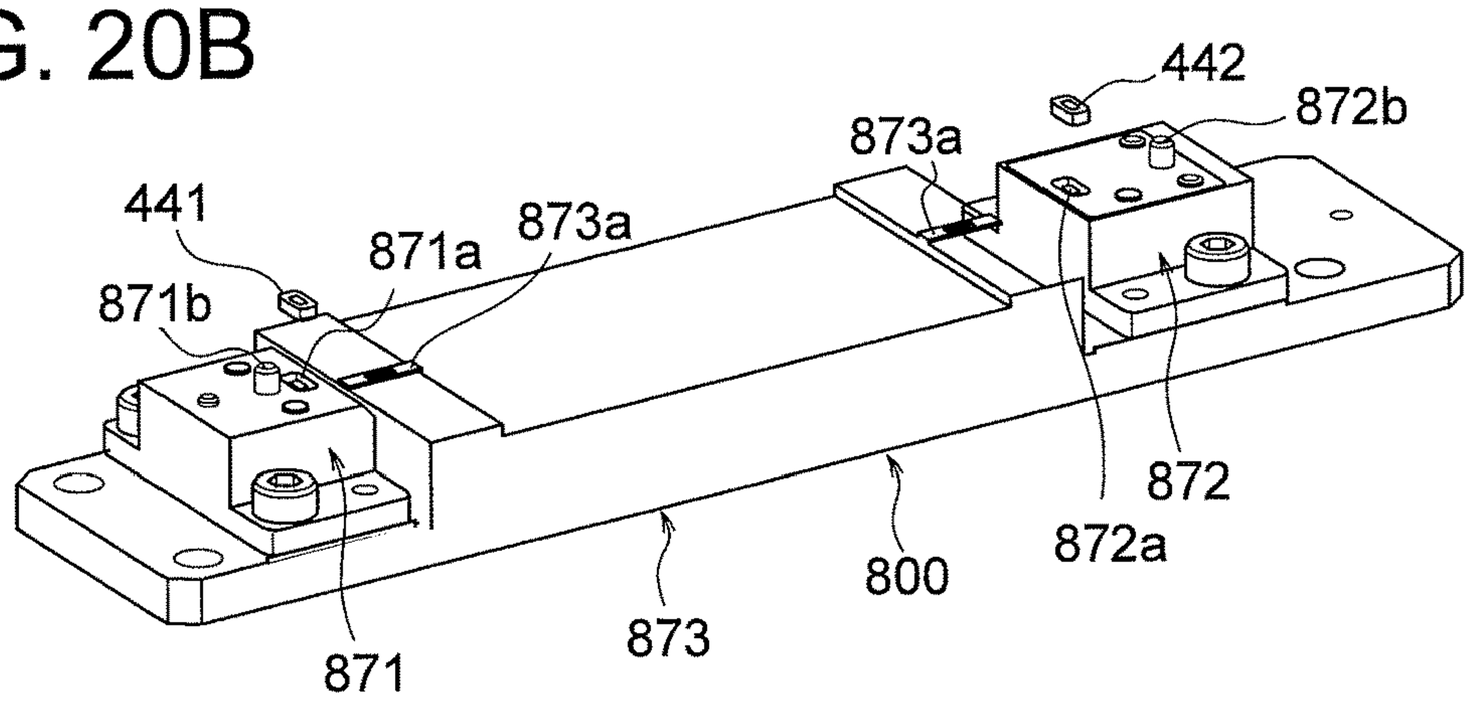

FIG. 21

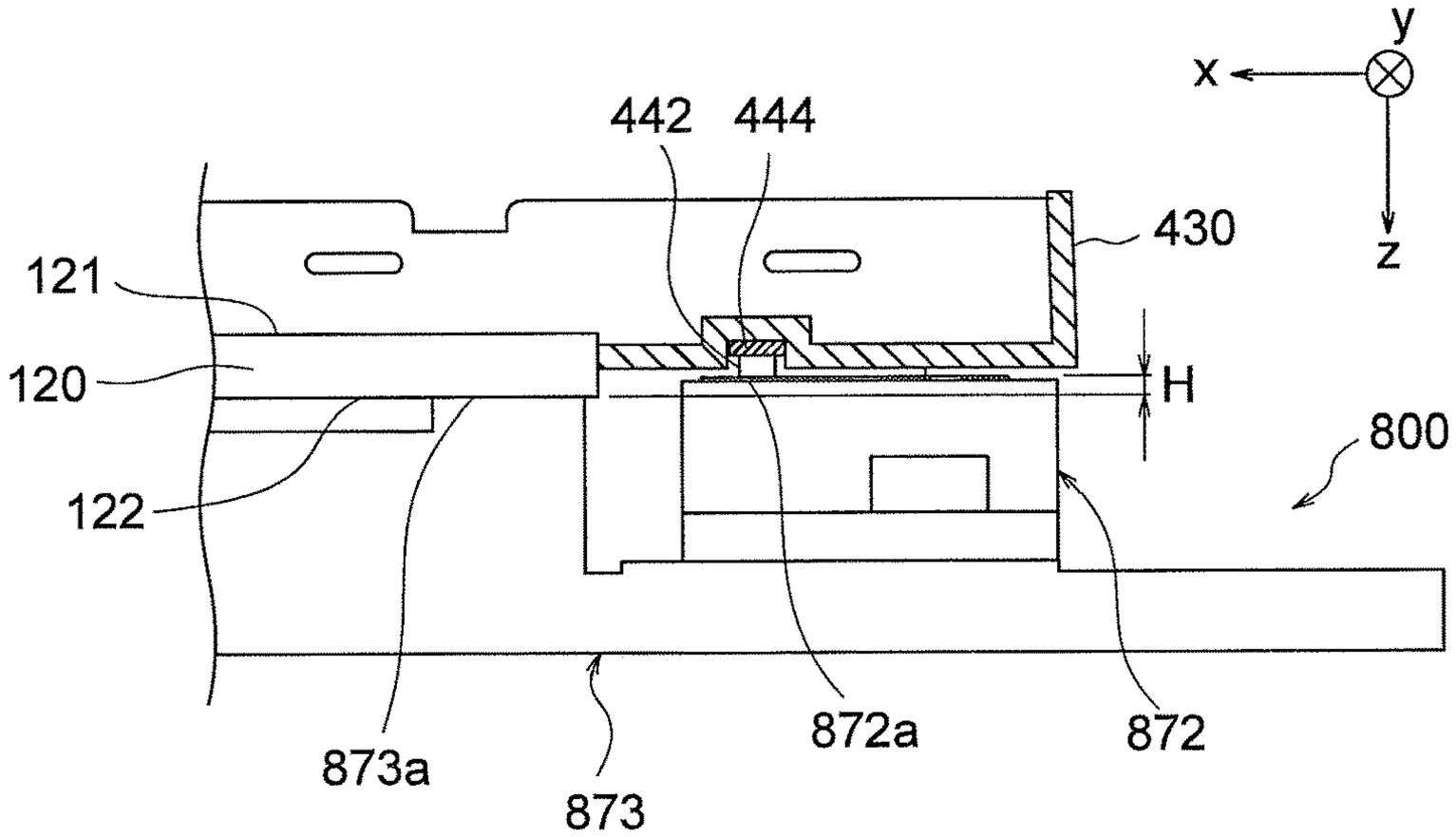

FIG. 22

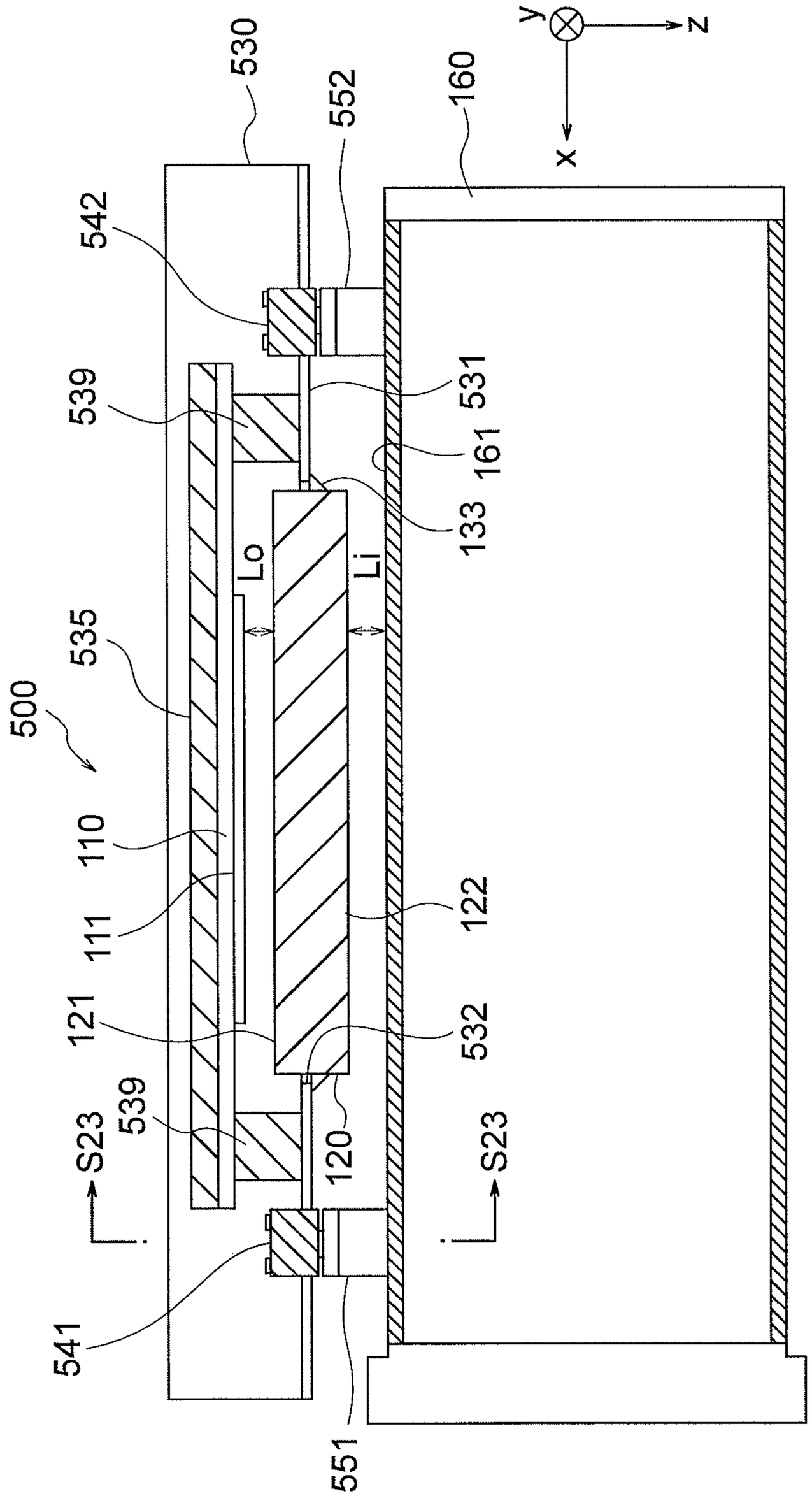
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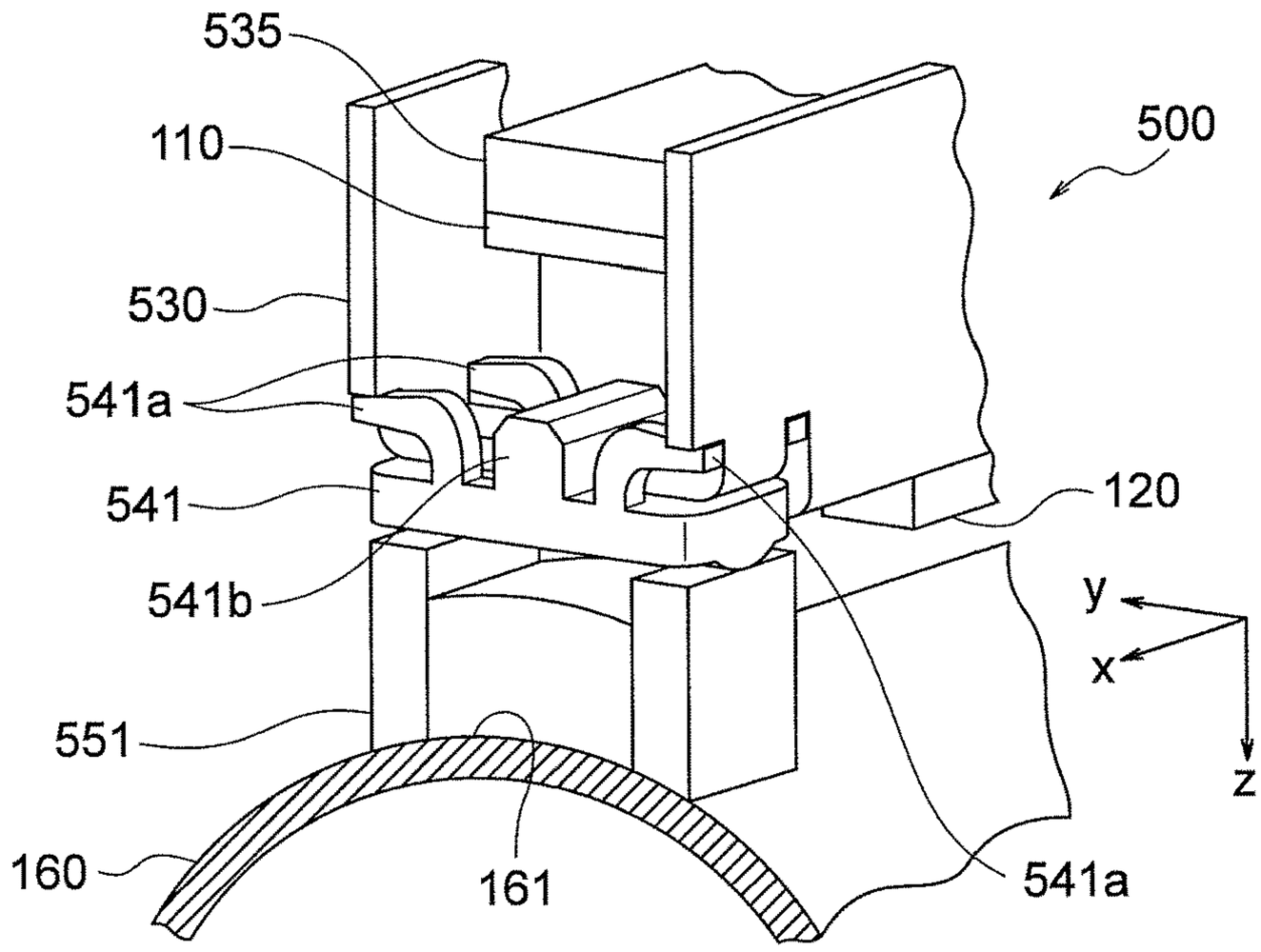
FIG. 23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541a

FIG. 24

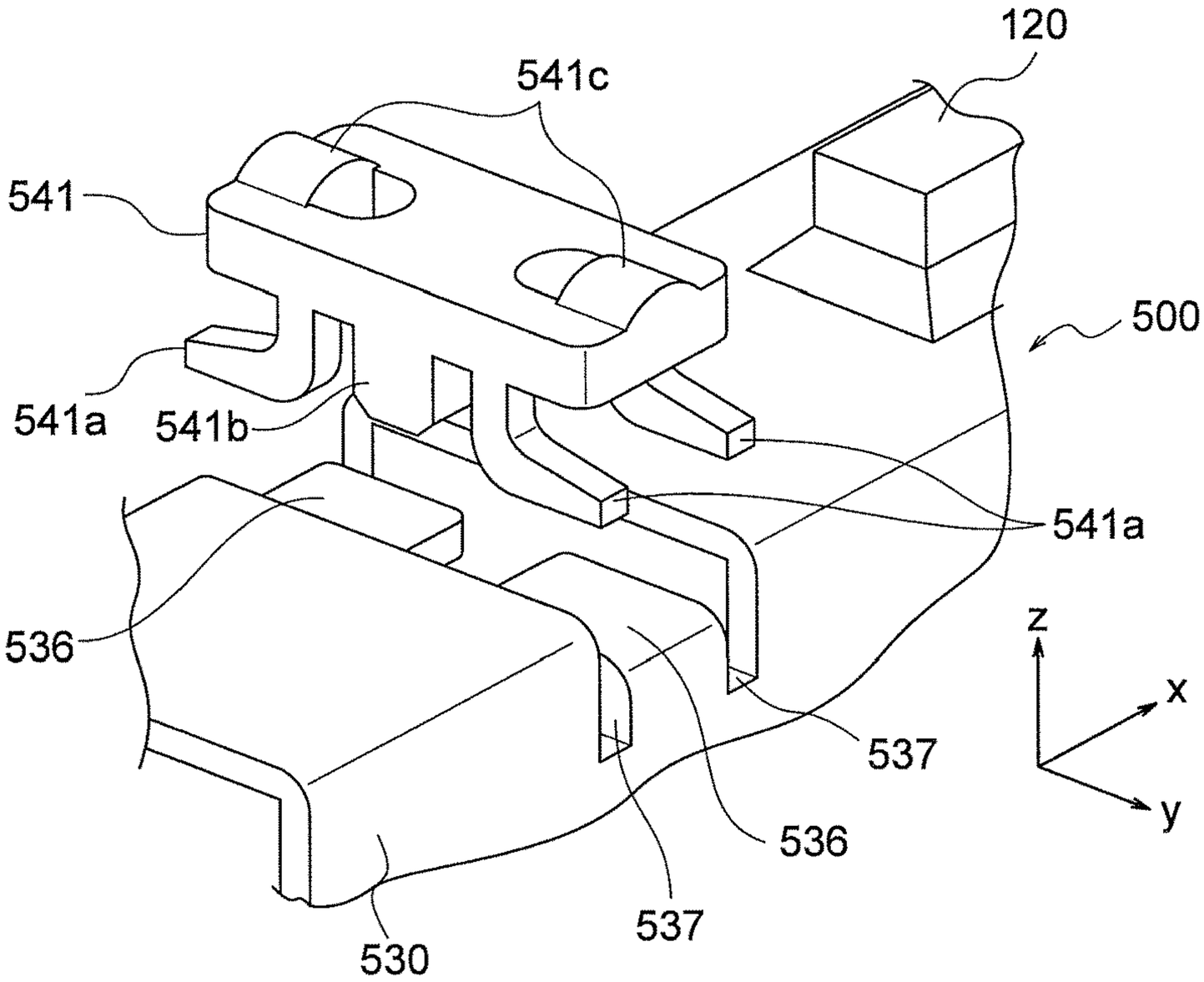

120
541c
541
500
541a
541b
541a
536
z
x
y
537
536
537
530

FIG. 25

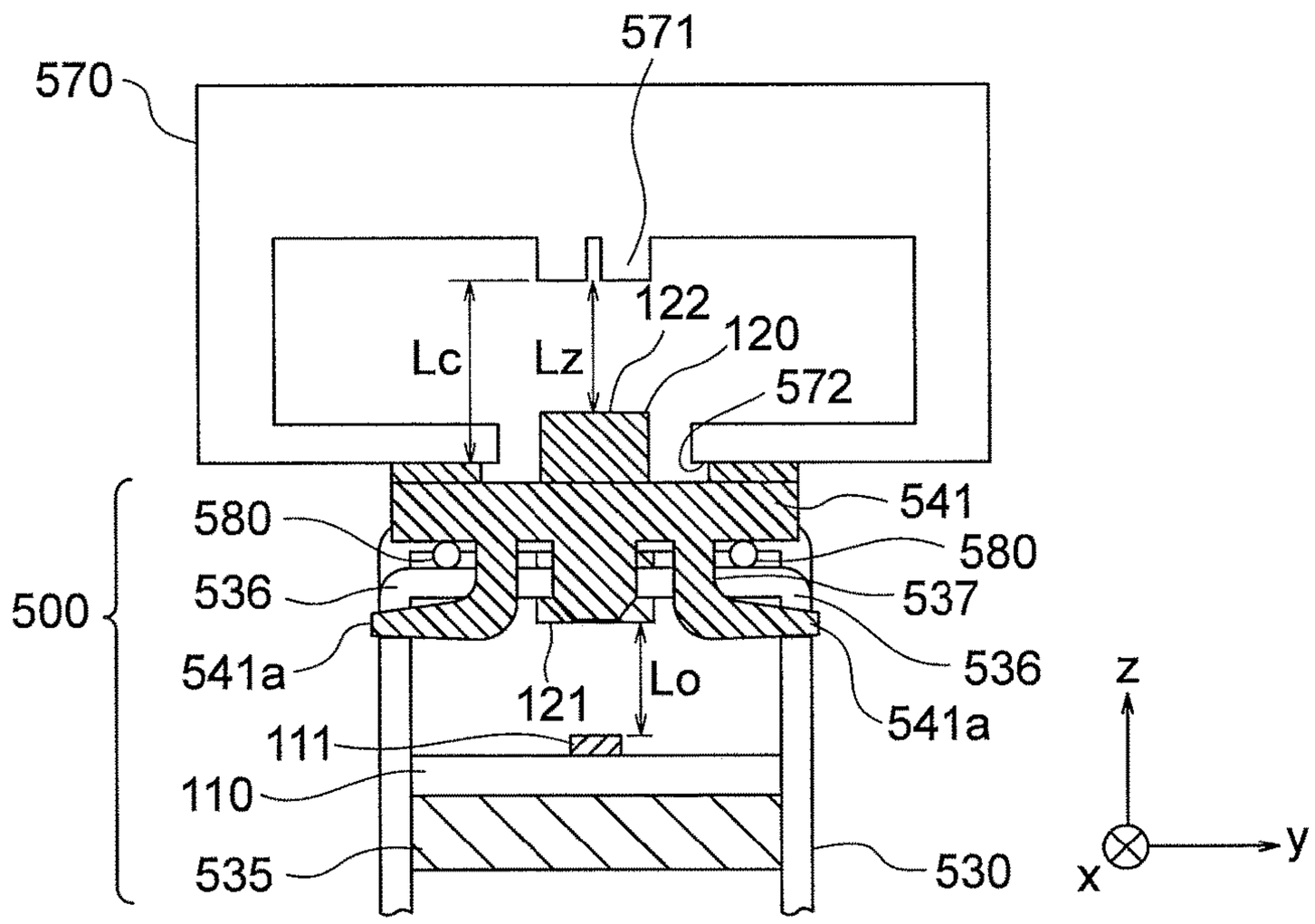

571
570
122
120
Lc
Lz
572
541
580
580
536
537
500
541a
536
Lo
121
541a
111
110
535
530
z
y
x

FIG. 26

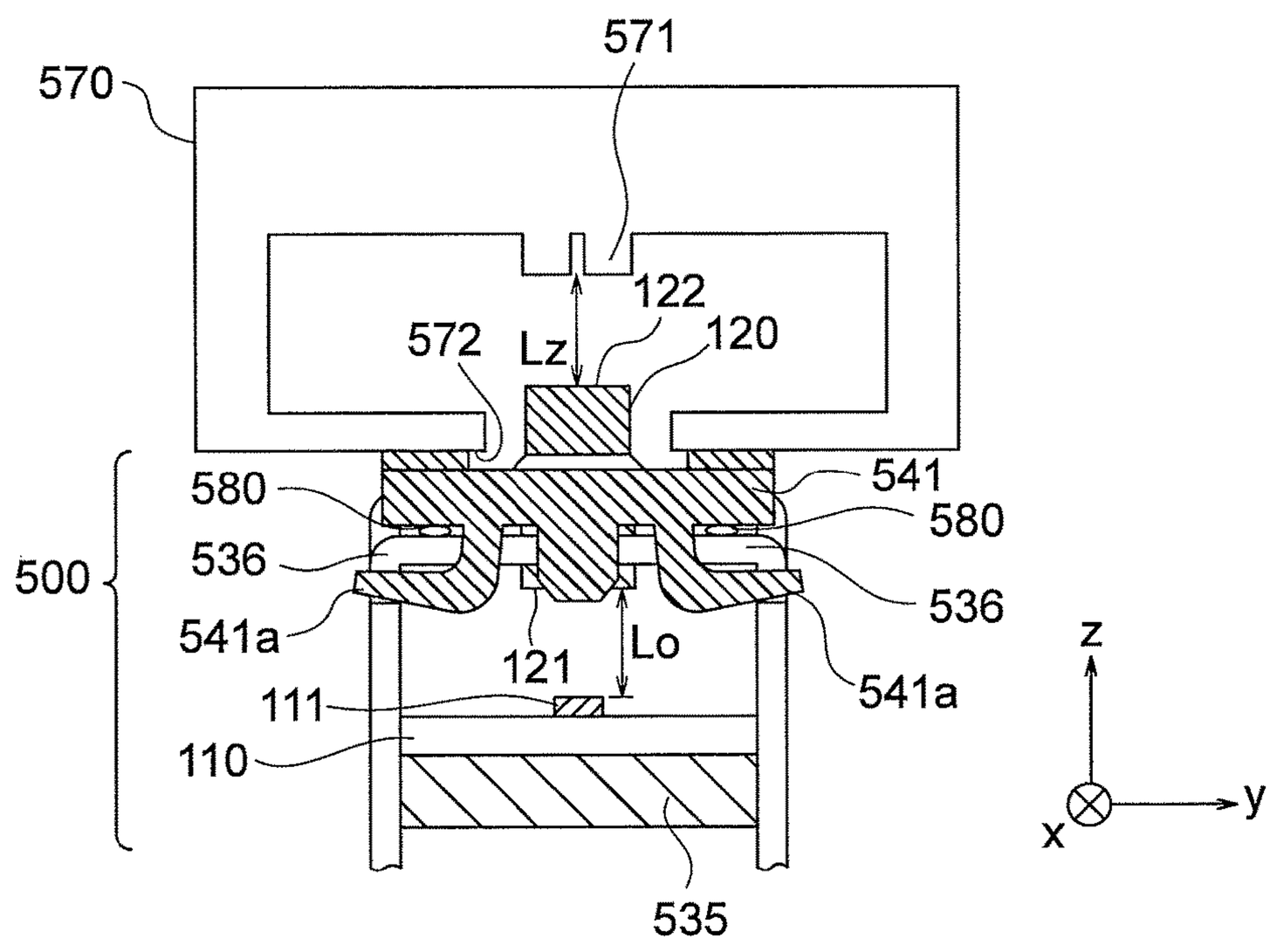

571
570
122
572
Lz
120
541
580
580
536
500
536
541a
Lo
121
541a
111
110
535
z
y
x

FIG. 27

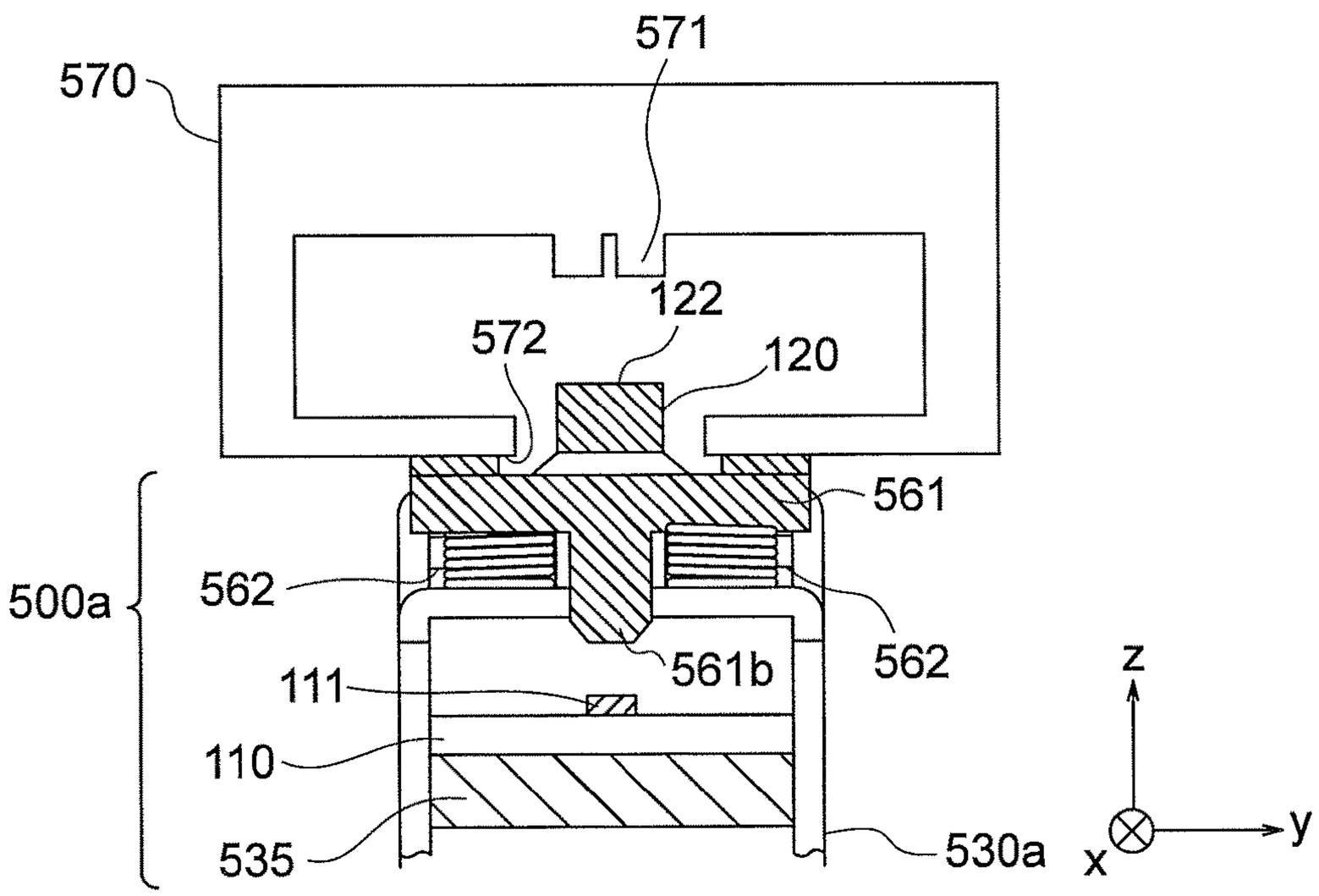
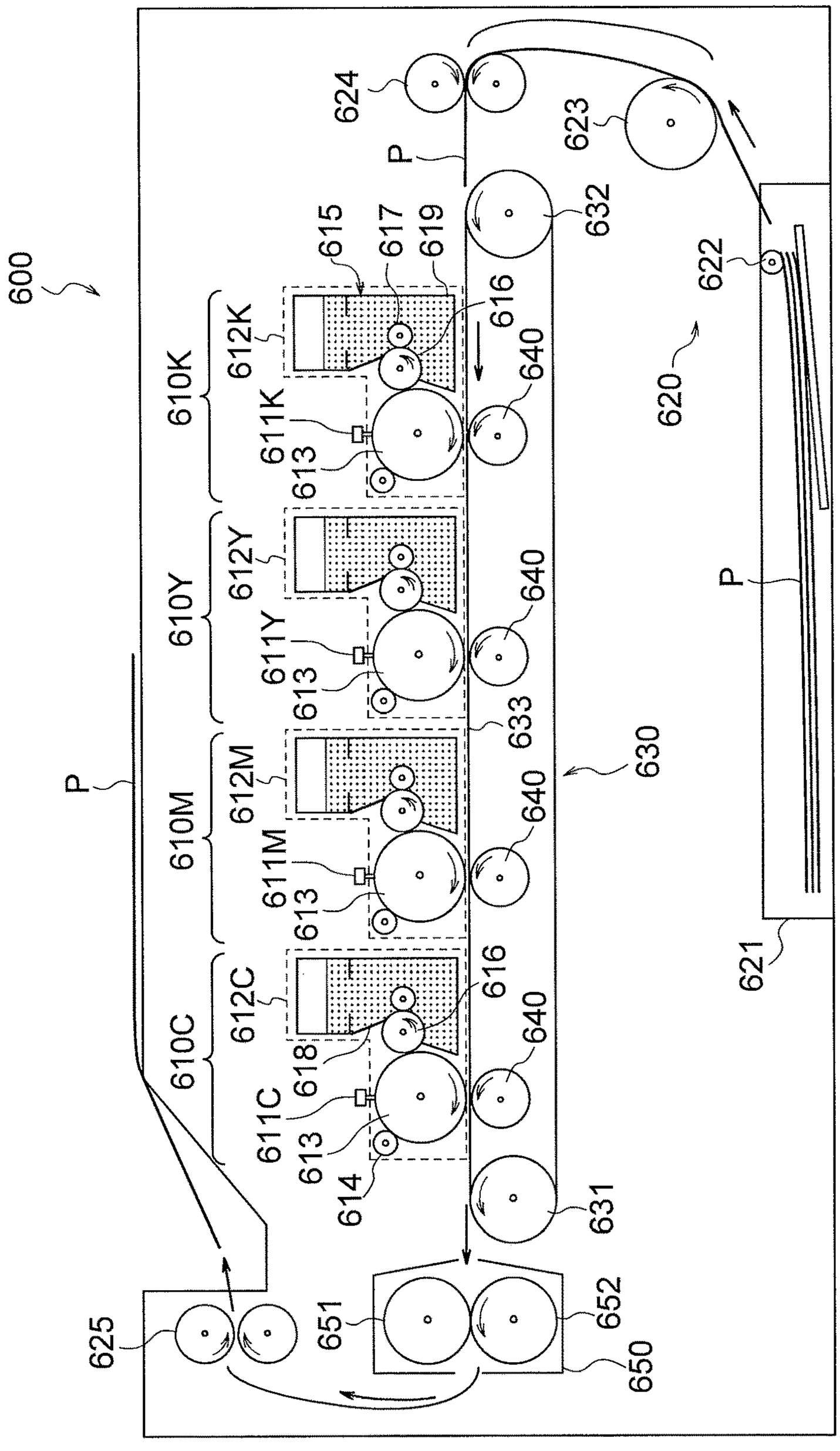


FIG. 28


600
624
623
P
632
615
617
619
622
616
612K
610K
640
620
611K
613
612Y
610Y
611Y
640
633
630
P
612M
610M
611M
640
612C
610C
611C
618
616
640
613
614
631
625
651
652
650
621

OPTICAL PRINT HEAD, IMAGE FORMING APPARATUS, AND METHOD OF MANUFACTURING THE OPTICAL PRINT HEAD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical print head, an image forming apparatus including the optical print head, and a method of manufacturing the optical print head.

2. Description of the Related Art

Japanese Patent Application Publication No. 2008-18700 discloses a light emitting element diode (LED) head as an exposure device of an electrophotographic image forming apparatus. The LED head includes a substrate on which an LED array chip is mounted, a rod lens array, and a holder holding the substrate and rod lens array. The holder faces a photosensitive drum via spacers. A clearance (or distance) between a surface of the rod lens array and a surface of the photosensitive drum is adjusted so that the rod lens array focuses light emitted from the LED array chip onto the surface of the photosensitive drum. The LED head includes eccentric cams for adjusting the clearance between the surface of the rod lens array and the surface of the photosensitive drum.

However, the LED head has a complicated structure requiring many parts, and thus is costly.

SUMMARY OF THE INVENTION

An aspect of the present invention is intended to provide an economical optical print head capable of maintaining a predetermined distance between a lens array and an image carrier, an image forming apparatus including the optical print head, and a method of manufacturing the optical print head.

According to an aspect of the present invention, there is provided an optical print head for illuminating an image carrier that faces the optical print head. The optical print head includes: a substrate on which a light emitting element array is mounted; a lens array for focusing light emitted from the light emitting element array onto the image carrier; a holder holding the substrate and the lens array; and at least one spacer member, disposed on the holder, for maintaining a predetermined distance between the lens array and the image carrier, the at least one spacer member being made of curable resin that is cured under a predetermined condition or fixed to the holder with curable adhesive that is cured under a predetermined condition.

According to another aspect of the present invention, there is provided an image forming apparatus including: an image carrier; and the above optical print head that illuminates the image carrier with light based on image data.

According to another aspect of the present invention, there is provided a method of manufacturing an optical print head for illuminating an image carrier that faces the optical print head. The method includes: placing a curable resin on a holder holding a substrate on which a light emitting element array is mounted and a lens array for focusing light emitted from the light emitting element array onto the image carrier; adjusting a height of the curable resin in a direction from the lens array to the image carrier; and curing the curable resin to form a cured product as a spacer member for maintaining a predetermined distance between the lens array and the image carrier.

According to another aspect of the present invention, there is provided a method of manufacturing an optical print head for illuminating an image carrier that faces the optical print head. The method includes: placing, on a holder holding a substrate on which a light emitting element array is mounted and a lens array for focusing light emitted from the light emitting element array onto the image carrier, a spacer member for maintaining a predetermined distance between the lens array and the image carrier, and a curable adhesive; adjusting a height of the spacer member in a direction from the lens array to the image carrier; and curing the curable adhesive to fix the spacer member to the holder.

BRIEF DESCRIPTION OF THE DRAWINGS

In the attached drawings:

FIG. **1**A is a perspective view schematically illustrating a structure of an optical print head according to a first embodiment of the present invention;

FIG. **1**B is an enlarged perspective view (including a sectional view) of the part **1**B in FIG. **1**A;

FIG. **1**C is an enlarged perspective view (including a sectional view) of the part **1**C in FIG. **1**A;

FIG. **2** is a perspective view (including a sectional view of the part **1**B in FIG. **1**A) schematically illustrating an optical print head according to the first embodiment, a spacer, and a photosensitive drum;

FIG. **3** is a perspective view (including a sectional view of the part **1**C in FIG. **1**A) schematically illustrating the optical print head according to the first embodiment, a spacer, and the photosensitive drum;

FIG. **4** is a perspective view (including a sectional view taken along line S**4**-S**4** in FIG. **1**A) schematically illustrating the optical print head according to the first embodiment and the photosensitive drum.

FIGS. **5**A to **5**D are perspective views (including sectional views) illustrating a process of producing abutment members of the optical print head according to the first embodiment;

FIGS. **6**A to **6**E are sectional views illustrating the process of producing an abutment member of the optical print head according to the first embodiment;

FIG. **7**A is a perspective view schematically illustrating a structure of an optical print head according to a modification of the first embodiment;

FIG. **7**B is an enlarged perspective view of the part **7**C in FIG. **7**A;

FIG. **7**C is an enlarged perspective view of the part **7**C (including abutment members) in FIG. **7**A;

FIG. **8** is a perspective view (including a sectional view of the part **7**C in FIG. **7**A) schematically illustrating the optical print head according to the modification of the first embodiment, a spacer, and a photosensitive drum;

FIG. **9**A is a perspective view schematically illustrating a structure of an optical print head according to a second embodiment of the present invention;

FIG. **9**B is an enlarged perspective view (including a sectional view) of the part **9**B in FIG. **9**A;

FIG. **9**C is an enlarged perspective view (including a sectional view) of the part **9**C in FIG. **9**A;

FIG. **10**A is a perspective view schematically illustrating a structure of an optical print head according to a modification of the second embodiment;

FIG. **10**B is an enlarged perspective view (including a sectional view) of the part **10**B in FIG. **10**A;

FIG. **10**C is an enlarged perspective view (including a sectional view) of the part **10**C in FIG. **10**A;

FIG. **11**A is a perspective view schematically illustrating a structure of an optical print head according to a third embodiment of the present invention;

FIG. **11**B is an enlarged perspective view of the part **11**B in FIG. **11**A;

FIG. **11**C is an enlarged perspective view (including a sectional view) of the part **11**B in FIG. **11**A;

FIG. **11**D is an enlarged perspective view (including a sectional view) of the part enclosed by the dashed line in FIG. **11**C;

FIGS. **12**A and **12**B are perspective views illustrating a process of producing abutment member and protective ring of the optical print head according to the third embodiment;

FIG. **13**A is a perspective view schematically illustrating a structure of an optical print head according to a modification of the third embodiment;

FIG. **13**B is an enlarged perspective view of the part **13**B in FIG. **13**A;

FIG. **13**C is an enlarged perspective view (including a sectional view) of the part **13**B in FIG. **13**A;

FIG. **13**D is an enlarged perspective view (including a sectional view) of the part enclosed by the dashed line in FIG. **13**C;

FIGS. **14**A and **14**B are perspective views illustrating a process of producing an abutment member and a protective ring of the optical print head according to the modification of the third embodiment;

FIG. **15** is a sectional view schematically illustrating a structure of an optical print head according to a fourth embodiment of the present invention;

FIG. **16** is a sectional view taken along line S**16**-S**16** in FIG. **15**;

FIG. **17** is a sectional view taken along line S**17**-S**17** in FIG. **15**;

FIG. **18** is a perspective view schematically illustrating the structure of the optical print head according to the fourth embodiment;

FIG. **19** is a sectional view schematically illustrating the structure of a main part of the optical print head according to the fourth embodiment;

FIG. **20**A is a perspective view schematically illustrating a structure of the optical print head according to the fourth embodiment;

FIG. **20**B is a perspective view schematically illustrating a process of positioning abutment members of the optical print head according to the fourth embodiment;

FIG. **21** is a sectional view schematically illustrating the process of positioning the abutment members of the optical print head according to the fourth embodiment;

FIG. **22** is a sectional view schematically illustrating a structure of an optical print head according to a fifth embodiment of the present invention;

FIG. **23** is a perspective view (including a sectional view taken along line S**23**-S**23** in FIG. **22**) schematically illustrating a structure of a main part of the optical print head according to the fifth embodiment;

FIG. **24** is an exploded perspective view schematically illustrating the structure of the main part of the optical print head according to the fifth embodiment;

FIG. **25** is a sectional view schematically illustrating a process of manufacturing the optical print head according to the fifth embodiment;

FIG. **26** is a sectional view schematically illustrating a process of manufacturing the optical print head according to the fifth embodiment;

FIG. **27** is a sectional view schematically illustrating a structure of an optical print head according to a modification of the fifth embodiment; and

FIG. **28** is a sectional view schematically illustrating a configuration of an image forming apparatus according to a sixth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Optical print heads according to embodiments of the present invention, an image forming apparatus including optical print heads, and methods of manufacturing optical print heads will be described below with reference to the attached drawings. The drawings show the coordinate axes of an xyz orthogonal coordinate system. The x-axis is a coordinate axis in a longitudinal direction (or main scanning direction) of the optical print heads according to the embodiments. The y-axis is a coordinate axis in a width direction (or sub scanning direction) of the optical print heads. The z-axis is a coordinate axis in a direction in which the optical print heads emit light. In the drawings, like elements are given like reference characters.

1 First Embodiment

<1-1> Structure

FIG. **1**A is a perspective view schematically illustrating a structure of an optical print head **100** according to the first embodiment of the present invention. FIG. **1**B is an enlarged perspective view (including a sectional view) of the part **1**B in FIG. **1**A. FIG. **1**C is an enlarged perspective view (including a sectional view) of the part **1**C in FIG. **1**A. FIG. **2** is a perspective view (including a sectional view of the part **1**B) schematically illustrating the optical print head **100**, a spacer **151** as a distance reference member, and a photosensitive drum **160** as an image carrier. FIG. **3** is a perspective view (including a sectional view of the part **1**C) schematically illustrating the optical print head **100**, a spacer **152**, and the photosensitive drum **160**. FIG. **4** is a perspective view (including a sectional view taken along line S**4**-S**4** in FIG. **1**A) schematically illustrating the optical print head **100** and photosensitive drum **160**.

As illustrated in FIGS. **2** to **4**, the optical print head **100** is an exposure device for illuminating a surface **161** of the photosensitive drum **160** that faces the optical print head **100**. In this embodiment, the photosensitive drum **160** is disposed to face the optical print head **100** via the pair of spacers **151** and **152**. As illustrated in FIG. **4**, the optical print head **100** includes a mounting substrate (or board) **110** on which a light emitting element array **111** is mounted, a lens array **120** that focuses or images light emitted from the light emitting element array **111** onto the surface **161** of the photosensitive drum **160**, and a holder (or lens holder) **130** as a holding member that holds the mounting substrate **110** and lens array **120**. The light emitting array **111**, which may be composed of multiple light emitting element array chips, includes multiple light emitting elements arranged in the x direction. The lens array **120** is, for example, a microlens array including multiple microlenses (e.g., erecting equal magnification imaging lenses) arranged in a regular manner. An example of the lens array **120** is a Selfoc (registered trademark) lens array (SLA), which is a rod lens array. As illustrated in FIG. **4**, the lens array **120** has a first surface **121**

and a second surface **122**. The first surface **121** is an end surface (or back surface) on the light emitting element array **111** side of the lens array **120** and is a light incident surface. The second surface **122** is an end surface (or front surface) on the photosensitive drum **160** side of the lens array **120** and is a light emitting surface.

The optical print head **100** includes at least one spacer member for maintaining a predetermined distance between the lens array **120** and the photosensitive drum **160**. In this embodiment, as illustrated in FIGS. **1**A to **1**C, the optical print head **100** includes, as the at least one spacer member, abutment members **140** (**141**, **142**, and **143**) as first, second, and third spacer members that are made of resin and disposed on the holder **130**. The abutment members **141**, **142**, and **143** constitute an abutment portion. As illustrated in FIG. **2**, the abutment member **141** as the first spacer member abuts an end **151***a* of the spacer **151** on the −z side. As illustrated in FIG. **3**, the abutment member **142** as the second spacer member and the abutment member **143** as the third spacer member abut ends **152***a* and **152***b* of the spacer **152** on the −z side, respectively. The abutment members **141**, **142**, and **143** and the spacers **151** and **152**, which slide on the surface **161** of the photosensitive drum **160**, set or define a clearance or distance Li (shown in FIG. **4**) between the second surface **122** of the lens array **120** and the surface **161** of the photosensitive drum **160**. Specifically, the abutment members **141**, **142**, and **143** are made of, for example, curable resin, such as ultraviolet (UV) curable resin. The abutment members **141**, **142**, and **143** are formed by placing resin materials (or bodies of resin material), adjusting or setting thicknesses of the resin materials before being cured to proper values while observing images or optical images of the light emitting elements at a position corresponding to the surface **161** of the photosensitive drum **160** by an optical image measurement device (specifically, adjusting the thicknesses of the resin materials so that the observed optical image is proper), irradiating the resin materials having the properly adjusted thicknesses with ultraviolet light to cure the resin materials, and thereby forming cured products of the resin materials as the abutment members **141**, **142**, and **143**. The UV curable resin may be acrylic resin material, epoxy resin material, or other materials. The UV curable resin preferably has a glass transition temperature of 50° C. or higher. A method of adjusting the clearance Li will be described later in detail with reference to FIGS. **5**A to **5**D and **6**A to **6**E.

The holder **130** has a support surface (or lens support surface) **131** that faces the photosensitive drum **160**, and an opening (or slit) **132** formed in the support surface **131** and elongated in the x direction. The opening **132** is a through hole in which the lens array **120** is inserted. The lens array **120** is inserted in the opening **132** with its longitudinal direction parallel to the x direction, and is fixed to the support surface **131** with adhesive (e.g., UV adhesive). To prevent foreign matter, such as toner, from entering the inside (or light emitting element array **111** side) of the holder **130**, it is preferable to provide a sealing member **133** around the lens array **120** to seal the opening **132** in the holder **130**. The sealing member **133** is, for example, silicone-based.

As illustrated in FIGS. **1**A, **1**B, **2**, and **3**, in the first embodiment, the holder **130** has ends **134** and **135**; the abutment member **141** is formed (or fixed) on the support surface **131** on the end **134** side; the abutment members **142** and **143** are formed (or fixed) on the support surface **131** on the end **135** side. The abutment members **142** and **143** are aligned in the y direction on the support surface **131**. The clearance (or distance) Li between the lens array **120** and the photosensitive drum **160** is set or defined by the abutment members **141**, **142**, and **143** at the three points. This can prevent rotational displacement (or rattling) of the optical print head **100** about a virtual axis in the x direction. The abutment members **142** and **143** may be formed at different positions in the x direction.

As illustrated in FIGS. **1**B, **1**C, **2**, and **3**, in the first embodiment, the abutment members **141**, **142**, and **143** are formed directly on the support surface **131** of the holder **130**. The abutment members **141**, **142**, and **143** have thicknesses (in the z direction) of, for example, 1 mm or less.

The holder **130** has, for example, a sheet-metal structure formed by processing (e.g., boring and folding) a metal sheet. Instead of the processed metal sheet, the holder **130** may be formed of polycarbonate, acrylonitrile-butadiene-styrene (ABS) resin, or liquid crystal polymer, or may be formed by aluminum die casting.

The mounting substrate **110** is, for example, a chip-on-board (COB) produced by mounting the light emitting element array (e.g., multiple aligned light emitting element array chips) **111** on a printed wiring board via die bonding paste. The printed wiring board, which is the main component of the mounting substrate **110**, is formed by patterning a copper-clad laminate having a glass epoxy resin board as a core material. The light emitting element array **111** is, for example, a light emitting diode (LED) array including multiple LEDs or an organic electroluminescence (EL) array including multiple organic EL elements. Specifically, the light emitting element array **111** may be, for example, an LED array formed using single crystal semiconductor mainly composed of GaAs (gallium arsenide), or an LED array formed using single crystal semiconductor mainly composed of GaN (gallium nitride). The mounting substrate **110** is positioned and fixed on an inner wall of the holder **130** with adhesive (e.g., UV adhesive) so that a light emitting surface of the light emitting element array **111** faces the first surface **121** of the lens array **120** with a clearance (or distance) Lo therebetween. The mounting substrate **110** may be fixed to the holder **130** in other ways. For example, the mounting substrate **110** may be sandwiched and held by the inner wall of the holder **130** in the width direction (or y direction).

The mounting substrate **110** and lens array **120** are fixed to the holder **130** so that the clearance (or distance) Li between the second surface (or front surface) **122** of the lens array **120** and the surface **161** of the photosensitive drum **160** is equal (or substantially equal) to the clearance (or distance) Lo between the first surface (or back surface) **121** of the lens array **120** and the light emitting surface (or front surface) of the light emitting element array **111** after the thicknesses of the abutment members **141**, **142**, and **143** have been set (or adjusted). Due to variation in the focal length of the lens array **120**, variation in the position at which the mounting substrate **110** is fixed, variation in the flatness of the support surface **131** of the holder **130**, and other reasons, an image position on the surface **161** of the photosensitive drum **160** is slightly displaced from a designed position. To allow the abutment members **141**, **142**, and **143** to function as a focal point (or image position) adjustment mechanism, the lens array **120** and mounting substrate **110** are fixed to the holder **130** so that the distance Li is slightly smaller than the distance Lo before the abutment members **141**, **142**, and **143** are formed. The abutment members **141**, **142**, and **143** are formed directly on the support surface **131** of the holder **130** by adjusting, while observing the image position using an optical image measurement device (not illustrated), the distance Li so that light

emitted from the light emitting element array **111** is imaged at a position of the surface **161** of the photosensitive drum **160**, and curing resin materials for the abutment members while maintaining the adjusted distance Li. To prevent foreign matter, such as toner, from adhering to the light emitting surface of the light emitting element array **111**, a gap between the lens array **120** and the holder **130** is sealed by means of the sealing member **133**. The sealing member **133** is, for example, silicone-based.

<1-2> Manufacturing Method

A method of manufacturing the optical print head **100** for illuminating the photosensitive drum **160** that faces the optical print head **100** will be described. First, UV curable resins (or bodies of UV curable resin), which are curable resins before being cured, are placed at positions where the abutment members **141**, **142**, and **143** are to abut the holder **130**, on the holder **130** holding the mounting substrate **110** on which the light emitting element array **111** is mounted, and the lens array **120** for focusing light emitted from the light emitting element array **111**. Then, heights of the UV curable resins in a direction from the lens array **120** to the photosensitive drum **160** are adjusted. Specifically, an image imaged by the lens array **120** is observed by the optical image measurement device (or observation device), and the thicknesses of the UV curable resins are adjusted on the basis of the observed image. Then, the UV curable resins are cured to form cured products having the adjusted heights as the abutment members **141**, **142**, and **143**.

A method of setting or adjusting the thicknesses of the abutment members **141**, **142**, and **143** will now be described in detail. FIGS. **5**A to **5**D are perspective views (including sectional views) illustrating a process of producing the abutment members **141**, **142**, and **143** of the optical print head **100** according to the first embodiment. FIG. **5**C is an enlarged perspective view of the part **5**B in FIG. **5**B. First, the lens array **120** and mounting substrate **110** are fixed to the holder **130**, and the sealing member **133** and a sealing member **113** are provided to seal the periphery of the lens array **120** and a back surface of the mounting substrate **110**. Moreover, as illustrated in FIG. **5**A, to seal ends of the mounting substrate **110** in the x direction, sealing plates **114** are disposed in contact with the ends of the mounting substrate **110**.

Next, as illustrated in FIG. **5**A, the optical print head **100** is set so that it is supported by a spring **172** supported by a spring guide **171**, from a back side of the holder **130**. Then, a UV curable resin **141***a* for forming the abutment member **141** is dispensed (or supplied) to a position facing the spacer **151** on the support surface **131** of the holder **130**. Likewise, UV curable resins (not illustrated) for forming the abutment members **141** and **142** are dispensed to two positions facing the spacer **152** on the support surface **131** of the holder **130**. At this time, the heights (or thicknesses in the z direction) of the UV curable resins are preferably greater than final heights (or thicknesses) of the abutment members **141**, **142**, and **143**. Further, since the UV curable resins before being cured are pressed by an abutment plate **174** in a later step for adjusting their heights, it is preferable to adjust the amounts of the UV curable resins to prevent the UV curable resins from protruding outside the holder **130** in the sub scanning direction (or y direction).

Next, as illustrated in FIG. **5**B, the optical print head **100** is pushed up in the +z direction by the spring **172** so that the support surface **131** of the holder **130** abuts an end **173***a* on the −z side of a height adjustment pin **173**. At this time, the UV curable resins before being cured are pressed by the abutment plate **174** into plate shapes. To allow the UV curable resins to easily separate from the abutment plate **174** after UV curing, a release surface **175** is formed on a lower surface of the abutment plate **174**. The release surface **175** may be formed by coating a surface (or the lower surface in FIG. **5**B) of the abutment plate **174** with silicone or fluororesin. The release surface **175** is a surface against which the UV curable resins abut, as illustrated in FIG. **5**B. The height (or position in the z direction) of the release surface **175** corresponds to the position of ends (the end **151***a* in FIG. **2** and the ends **152***a* and **152***b* in FIG. **3**) on the −z side of the spacers **151** and **152** abutting an outer periphery of the photosensitive drum **160**. As illustrated in FIG. **5**B, a height (or position in the z direction) of a virtual position (indicated by the dashed-dotted line in FIG. **5**B) **176** of the surface **161** of the photosensitive drum **160** in the optical image measurement device corresponds to a height (or position in the z direction) of the surface **161** of the photosensitive drum **160** in an image forming apparatus. Then, by moving up and down (in the +z and −z directions) the height adjustment pin **173** while observing the imaging state using the optical image measurement device, the distance Li from the virtual position **176** of the surface **161** of the photosensitive drum **160** to the second surface **122** of the lens array **120** is adjusted so that the light is imaged or focused at the virtual position **176** of the surface **161** of the photosensitive drum **160**.

Then, by irradiating the UV curable resins with UV light from a UV light source **177** through the abutment plate **174** while maintaining the adjusted distance Li, the UV curable resins are cured into cured products as the abutment members **141**, **142**, and **143**. To irradiate the UV curable resins with UV light through the abutment plate **174**, the abutment plate **174** is preferably formed of transparent material (e.g., transparent glass).

Next, as illustrated in FIG. **5**D, the abutment members **141**, **142**, and **143** are separated from the release surface **175**.

FIGS. **6**A to **6**E are sectional views illustrating the process of producing the abutment member **141** of the optical print head **100** according to the first embodiment. First, as illustrated in FIG. **6**A, a UV curable resin (or a body of UV curable resin) **141***a* is dispensed onto the support surface **131** of the holder **130** using a dispenser. This step corresponds to the step of FIG. **5**A.

Next, as illustrated in FIG. **6**B or **6**C, the release surface **175** of the abutment plate **174** is brought into contact with the UV curable resin **141***a*. The thickness of the UV curable resin **141***a* may be adjusted by moving the holder **130** up in the +z direction (or one direction) as illustrated in FIG. **6**B, or by moving the holder **130** in the +z and −z directions (or up and down directions) as illustrated in FIGS. **6**C. In the case of FIG. **6**B, when the holder **130** is moved up in one direction, the UV curable resin **141***a* is pressed and crushed against the release surface **175** to have a height (or thickness) equal to a length of a gap between the release surface **175** and the holder **130**. In the case of FIG. **6**C, after the UV curable resin **141***a* is moved in the +z direction and greatly crushed against the release surface **175**, the height of the UV curable resin **141***a* is adjusted by moving the holder **130** away from the release surface **175**. At this time, the surface tension of the UV curable resin **141***a* relative to the release surface **175** allows the UV curable resin **141***a* to follow the movement of the holder **130** in the up and down directions while being attracted by the release surface **175**. When it is difficult to ensure the final height of the abutment member **141** (or the thickness of the UV curable resin **141***a* in FIG. **6**D) due to variation in the height of the UV curable resin

141*a* (or the thickness of the UV curable resin **141***a* in FIG. **6**A), it is preferable to employ the method of FIG. **6**C.

Next, as illustrated in FIG. **6**D, while the adjusted height (or thickness) of the UV curable resin **141***a* is maintained, the UV curable resin **141***a* is irradiated with UV light from the UV light source **177** through the abutment plate **174** and thereby cured. The steps of FIGS. **6**B to **6**D correspond to the step of FIG. **5**B.

Next, as illustrated in FIG. **6**E, the holder **130** is moved in the −z direction, and thereby the abutment member **141** is separated from the release surface **175**. The abutment members **142** and **143** are formed in the same manner as the abutment member **141**.

<1-3> Advantages

In the optical print head **100** according to the first embodiment, the abutment portion of the optical print head **100** that abuts the spacers **151** and **152** can be constituted by the abutment members **141**, **142**, and **143** made of resin. Further, the abutment members **141**, **142**, and **143** can be formed directly on the support surface **131** of the holder **130**. This can reduce the number of parts as compared to the prior art. This can reduce the assembly time.

Further, in the optical print head **100** according to the first embodiment, the abutment members **141**, **142**, and **143** can be formed (or fixed) directly on a flat portion of the support surface **131** of the holder **130**. This can allow the holder **130** to be a simple sheet-metal structure, thereby reducing the cost of the optical print head as compared to the prior art, which requires processing of a holder for installation of an adjustment member.

Further, in the optical print head **100** according to the first embodiment, the abutment members **141**, **142**, and **143** are formed by supplying UV curable resins directly onto the support surface **131** of the holder **130** and curing the UV curable resins. This can reduce the number of manufacturing steps as compared to a method including a step of supplying adhesive to an adjustment member after adjustment of the distance Li. This can reduce the cost of the optical print head.

Further, in the optical print head **100** according to the first embodiment, the abutment members **141**, **142**, and **143** can be formed on the holder **130** to have very small thicknesses, e.g., of 1 mm or less. This can reduce variation in the distance Li between the photosensitive drum **160** and the lens array **120** due to variation in the ambient temperature of the optical print head as compared to the prior art. This can stabilize characteristics of the optical print head.

<1-4> Modification

FIG. **7**A is a perspective view schematically illustrating a structure of an optical print head **100***a* according to a modification of the first embodiment. FIGS. **7**B and **7**C are enlarged perspective views of the part **7**C in FIG. **7**A. FIG. **7**C illustrates abutment members, which are not illustrated in FIG. **7**B. In FIGS. **7**A to **7**C, elements that are the same as or correspond to those in FIGS. **1**A and **1**C have the same reference characters. FIG. **8** is a perspective view schematically illustrating the optical print head **100***a* according to the modification of the first embodiment, a spacer **153**, and the photosensitive drum **160**. FIG. **8** includes a sectional view of the part **7**C in FIG. **7**A. In FIG. **8**, elements that are the same as or correspond to those in FIG. **3** have the same reference characters.

The optical print head **100***a* according to the modification of the first embodiment differs from the optical print head **100** according to the first embodiment in that, while the support surface **131** has a constant width, the support surface **131***a* of the holder **130***a* has, on the end **135** side, a wide portion (or protruding portion) **136**, and abutment members **142***a* and **143***a* made of resin are disposed near both ends of the wide portion **136** in the width direction (or y direction). The abutment members **142***a* and **143***a* of the optical print head **100***a* are the same as the abutment members **142** and **143** of the optical print head **100** except that they are disposed at the both ends of the wide portion **136** in the support surface **131***a* of the holder **130***a*. The distance D between center positions of the abutment members **142***a* and **143***a* of the optical print head **100***a* is greater than the distance between center positions of the abutment members **142** and **143** of the optical print head **100**. The spacer **153**, which is disposed between the optical print head **100***a* and the photosensitive drum **160**, has ends **153***a* and **153***b* on the −z side, at positions corresponding to the positions of the abutment members **142***a* and **143***a*.

In the modification of the first embodiment, the abutment member **141** is formed (or fixed) on the support surface **131***a* on the end **134** side of the holder **130***a*. As illustrated in FIGS. **7**A and **7**C, the abutment members **142***a* and **143***a* are formed (or fixed) on the support surface **131***a* on the end **135** side of the holder **130***a*. The abutment members **142***a* and **143***a* are also aligned in the y direction on the support surface **131***a*. The clearance (or distance) Li between the lens array **120** and the photosensitive drum **160** is set or defined by the abutment members **141**, **142***a*, and **143***a* at the three points. This can prevent rattling of the optical print head **100***a*. The abutment members **142***a* and **143***a* may be located at different positions in the x direction.

As described above, in the optical print head **100***a* according to the modification of the first embodiment, the distance D between the center positions of the abutment members **142***a* and **143***a* is great. This can further prevent rotational displacement (or rattling) of the optical print head **100***a* about a virtual axis in the x direction.

Except for the above, the optical print head **100***a* according to the modification is the same as the optical print head **100**.

The abutment members **142** and **143** of the optical print head **100** may be replaced with a single abutment member elongated in the y direction. Likewise, the abutment members **142***a* and **143***a* of the optical print head **100***a* may be replaced with a single abutment member elongated in the y direction.

2 Second Embodiment

<2-1> Structure

FIG. **9**A is a perspective view schematically illustrating a structure of an optical print head **200** according to a second embodiment of the present invention. FIG. **9**B is an enlarged perspective view (including a sectional view) of the part **9**B in FIG. **9**A. FIG. **9**C is an enlarged perspective view (including a sectional view) of the part **9**C in FIG. **9**A. In FIGS. **9**A to **9**C, elements that are the same as or correspond to those in FIGS. **1**A to **1**C have the same reference characters. The optical print head **200** according to the second embodiment differs from the optical print head **100** according to the first embodiment in that a holder **230** has through holes **231***a*, **231***b*, and **231***c* at positions where abutment members **241**, **242**, and **243** are formed on a support surface **231**, and the abutment members **241**, **242**, and **243** are formed on the through holes **231***a*, **231***b*, and **231***c* in such a manner as to fill the through holes **231***a*, **231***b*, and **231***c*. The through holes **231***a*, **231***b*, and **231***c* may have diameters of, for example, 2 mm or less.

The abutment member **241** as a first spacer member, the abutment member **242** as a second spacer member, and the abutment member **243** as a third spacer member, which are formed on the support surface **231** of the holder **230** of the optical print head **200**, have the same functions as the abutment members **141**, **142**, and **143** of the first embodiment. The abutment members **241**, **242**, and **243** can be formed by, for example, dispensing UV curable resins, which are curable resins before being cured, to the through holes **231***a*, **231***b*, and **231***c* in the holder **230** by a dispenser, and then curing the UV curable resins in the same manner as the steps illustrated in FIGS. **5**A to **5**D and **6**A to **6**E. To prevent the UV curable resin before being cured from passing through the through holes **231***a*, **231***b*, and **231***c* and scattering onto an upper surface of the mounting substrate (or COB) **110**, an opening diameter of a dispensing nozzle of the dispenser for supplying UV curable resin before being cured is preferably greater than diameters of the through holes **231***a*, **231***b*, and **231***c*.

<2-2> Advantages

In the optical print head **200** according to the second embodiment, the abutment members **241**, **242**, and **243** are formed and cured in such a manner as to fit into the through holes **231***a*, **231***b*, and **231***c* in the holder **230**. This can improve the strength of the abutment members **241**, **242**, and **243** against a shear force in a lateral direction (or a direction parallel to the support surface **231**).

In the optical print head **200** according to the second embodiment, the abutment portion of the optical print head **200** that abuts the spacers can be constituted by the abutment members **241**, **242**, and **243** made of resin. Further, the abutment members **241**, **242**, and **243** can be formed on the support surface **231** of the holder **230**. This can reduce the number of parts as compared to the prior art. This can reduce the assembly time.

Further, in the optical print head **200** according to the second embodiment, the abutment members **241**, **242**, and **243** can be formed (or fixed) directly on the support surface **231** of the holder **230** at positions of the through holes **231***a*, **231***b*, and **231***c*. This can allow the holder **230** to be a simple sheet-metal structure. This can reduce the cost of the optical print head as compared to the prior art, which requires processing of a holder for installation of an adjustment member.

Further, in the optical print head **200** according to the second embodiment, the abutment members **241**, **242**, and **243** are formed by supplying UV curable resins directly onto the support surface **231** of the holder **230** and curing the UV curable resins. This can reduce the number of manufacturing steps as compared to a method including a step of supplying adhesive to an adjustment member after adjustment of the distance Li. This can reduce the cost of the optical print head.

Further, in the optical print head **200** according to the second embodiment, the abutment members **241**, **242**, and **243** can be formed on the holder **230** to have very small thicknesses. This can reduce variation in the distance Li between the photosensitive drum **160** and the lens array **120** due to variation in the ambient temperature of the optical print head as compared to the prior art. This can stabilize characteristics of the optical print head.

<2-3> Modification

FIG. **10**A is a perspective view schematically illustrating a structure of an optical print head **200***a* according to a modification of the second embodiment. FIG. **10**B is an enlarged perspective view (including a sectional view) of the part **10**B in FIG. **10**A. FIG. **10**C is an enlarged perspective view (including a sectional view) of the part **10**C in FIG. **10**A. In FIGS. **10**A to **10**C, elements that are the same as or correspond to those in FIGS. **9**A to **9**C have the same reference characters. The optical print head **200***a* according to the modification of the second embodiment differs from the optical print head **200** according to the second embodiment in that a holder **230***a* has recesses **232***a*, **232***b*, and **232***c* at positions where abutment members **241***a*, **242***a*, and **243***a* are formed on a support surface **232**, and the abutment members **241***a*, **242***a*, and **243***a* are formed to fill the recesses **232***a*, **232***b*, and **232***c*.

The abutment members **241***a*, **242***a*, and **243***a*, which are formed on the support surface **232** of the holder **230***a* of the optical print head **200***a*, have the same functions as the abutment members **141**, **142**, and **143** of the first embodiment. The abutment members **241***a*, **242***a*, and **243***a* can be formed by, for example, dispensing UV curable resins before being cured to the recesses **232***a*, **232***b*, and **232***c* in the support surface **232** of the holder **230***a* by a dispenser, and then curing the UV curable resins in the same manner as the steps illustrated in FIGS. **5**A to **5**D and **6**A to **6**E. The abutment members **241***a*, **242***a*, and **243***a* made of the UV curable resin have diameters greater than the recesses **232***a*, **232***b*, and **232***c*, and are formed to fill the recesses **232***a*, **232***b*, and **232***c*.

As described above, in the optical print head **200***a* according to the modification of the second embodiment, the recesses **232***a*, **232***b*, and **232***c* are formed in the support surface **232** of the holder **230***a* on which the abutment members **241***a*, **242***a*, and **243***a* are formed. Thus, when UV curable resin is dispensed to the recesses **232***a*, **232***b*, and **232***c*, no UV curable resin scatters onto a surface of the mounting substrate **110**.

Except for the above, the optical print head **200***a* according to the modification is the same as the optical print head **200**.

The through holes **231***b* and **231***c* of the optical print head **200** may be replaced with a single through hole, and the abutment members **242** and **243** may be replaced with a single abutment member elongated in the y direction. Likewise, the recesses **232***b* and **232***c* of the optical print head **200***a* may be replaced with a single recess, and the abutment members **242***a* and **243***a* may be replaced with a single abutment member elongated in the y direction.

Further, the optical print heads **200** and **200***a* may have a wide portion as illustrated in FIG. **7**C.

The through holes **231***a*, **231***b*, and **231***c* of the optical print head **200** and the recesses **232***a*, **232***b*, and **232***c* of the optical print head **200***a* can be formed by applying extrusion processing to the holder **230** and **230***a*. The holder **230** and **230***a* may be formed by aluminum die casting or may be formed of resin, such as polycarbonate, ABS resin, or liquid crystal polymer.

3 Third Embodiment

<3-1> Structure

FIG. **11**A is a perspective view schematically illustrating a structure of an optical print head **300** according to a third embodiment of the present invention. FIG. **11**B is an enlarged perspective view of the part **11**B in FIG. **11**A. FIG. **11**C is an enlarged perspective view (including a sectional view) of the part **11**B in FIG. **11**A. FIG. **11**D is an enlarged perspective view (including a sectional view) of the part enclosed by the dashed line in FIG. **11**C. In FIGS. **11**A to **11**D, elements that are the same as or correspond to those in FIGS. **1**A to **1**C have the same reference characters. The

optical print head **300** according to the third embodiment differs from the optical print head **100** according to the first embodiment in that protective rings **343** and **344** are formed to surround an outer periphery of an abutment member **341** as a first spacer member and an outer periphery of an abutment member **342** as a second spacer member on a support surface **331** of a holder **330**, respectively. The protective rings **343** and **344** are made using low modulus silicone material. As illustrated in FIG. **11**A, the abutment member **342** has an elliptical shape elongated in the y direction as viewed in the z direction. However, the abutment member **342** and protective ring **344** may be replaced with two abutment members like the abutment members **142** and **143** in FIG. **1** and two protective rings made using low modulus silicone material. In this case, the two abutment members may have circular shapes as viewed in the z direction.

The abutment members **341** and **342** are formed by dispensing UV curable resins as curable resins directly onto the holder **330** and irradiating the UV curable resins with UV light to cure the UV curable resins. The method of forming the abutment members **341** and **342** is the same as that of the first embodiment illustrated in FIGS. **5**A to **5**D and **6**A to **6**E. The protective rings **343** and **344** are formed to surround the outer peripheries of the abutment members **341** and **342** and adhere to the support surface **331** of the holder **330**.

FIGS. **12**A and **12**B are perspective views illustrating a process of producing the abutment member **341** and protective ring **343** of the optical print head **300** according to the third embodiment. The abutment member **341** is formed on the support surface **331** of the holder **330** in the same manner as in the first embodiment. Then, the protective ring **343** is formed by dispensing (or supplying) low modulus silicone material from a dispensing nozzle **350** of a dispenser onto the support surface **331** while moving the dispensing nozzle **350** along the outer periphery of the abutment member **341**. The abutment member **342** and protective ring **344** are formed in the same manner.

<3-2> Advantages

In the optical print head **300** according to the third embodiment, the protective rings **343** and **344** made of low modulus silicone are formed around the abutment members **341** and **342**. Thereby, when the spacers, which are members corresponding to the spacers **151** and **152** in FIGS. **2** and **3**, abut the abutment members **341** and **342**, edges of the abutment members **341** and **342** are less likely to be damaged or chipped. Further, even if the abutment member **341** or **342** is broken to produce broken pieces, since the abutment members **341** and **342** are sealed by the protective rings **343** and **344**, the broken pieces are less likely to scatter and adhere to a surface of the photosensitive drum **160**.

The optical print head **300** according to the third embodiment can be composed of a smaller number of parts than the prior art. This can reduce the assembly time.

Further, in the optical print head **300** according to the third embodiment, the holder **330** can be a simple sheet-metal structure. This can reduce the cost as compared to the prior art.

Further, in the optical print head **300** according to the third embodiment, the abutment members **341** and **342** can be formed to be very thin. This can reduce variation in the distance Li between the photosensitive drum **160** and the lens array **120** due to temperature variation, thereby stabilizing characteristics of the optical print head.

<3-3> Modification

FIG. **13**A is a perspective view schematically illustrating a structure of an optical print head **300***a* according to a modification of the third embodiment. FIG. **13**B is an enlarged perspective view of the part **13**B in FIG. **13**A. FIG. **13**C is an enlarged perspective view (including a sectional view) of the part **13**B in FIG. **13**A. FIG. **13**D is an enlarged perspective view (including a sectional view) of the part enclosed by the dashed line in FIG. **13**C. In FIGS. **13**A to **13**D, elements that are the same as or correspond to those in FIGS. **11**A to **11**D have the same reference characters. The optical print head **300***a* according to the modification of the third embodiment differs from the optical print head **300** according to the third embodiment in that a support surface **331***a* of a holder **330***a* has recesses (one of which is denoted by reference character **332** in FIGS. **13**D and **14**A), and abutment members **341***a* and **342***a* are formed in the recesses formed in the support surface **331***a*. As illustrated in FIG. **13**A, the abutment member **342***a* has an elliptical shape elongated in the y direction as viewed in the z direction. However, the abutment member **342***a* and a protective ring **344***a* may be replaced with two abutment members like the abutment members **142** and **143** in FIG. **1** and two protective rings made using low modulus silicone material. In this case, the two abutment members may have circular shapes as viewed in the z direction.

In the optical print head **300***a*, the abutment members **341***a* and **342***a* are formed in the recesses in the support surface **331***a* of the holder **330***a* so that each of them adheres to a bottom surface of the corresponding recess and has a diameter smaller than a diameter of the bottom surface of the recess. The protective rings **343***a* and **344***a* are formed around the abutment members **341***a* and **342***a* to fill spaces in the recesses outside the abutment members **341***a* and **342***a*. The method of forming the abutment members **341***a* and **342***a* is the same as that of the first embodiment illustrated in FIGS. **5**A to **5**D and **6**A to **6**E.

FIGS. **14**A and **14**B are perspective views illustrating a process of producing the abutment member **341***a* and protective ring **343***a* of the optical print head **300***a* according to the modification of the third embodiment. First, the recess **332** is formed by extrusion processing at a position where the abutment member **341***a* is to be formed, in the support surface **331***a* of the holder **330***a*. Then, the abutment member **341***a* is formed on the bottom surface of the recess **332**. Then, the protective ring **343***a* is formed by dispensing low modulus silicone material from the dispensing nozzle **350** while moving the dispensing nozzle **350** along the outer periphery of the abutment member **341***a*. When the viscosity of the low modulus silicone material is extremely low (e.g., less than 5 Pa·s), it is possible to fill the space in the recess **332** around the abutment member **341***a* with the low modulus silicone material by taking advantage of flow of the low modulus silicone material without moving the dispensing nozzle **350** along the outer periphery of the abutment member **341***a*. The abutment member **342***a* and protective ring **344***a* are formed in the same manner.

As described above, in the optical print head **300***a* according to the modification of the third embodiment, the recesses are formed in the support surface **331***a* of the holder **330***a* on which the abutment members **341***a* and **342***a* are formed. Thus, when UV curable resin is dispensed in the recesses, the UV curable resin is less likely to scatter onto a surface of the mounting substrate **110**.

Further, in the optical print head **300***a*, the protective rings **343***a* and **344***a* are formed of low modulus silicone to fill the spaces in the recesses outside the abutment members **341***a* and **342***a*. The protective rings can be formed in such a

manner as to tightly adhere to the outer peripheries of the abutment members **341***a* and **342***a*. Further, when the viscosity of the low modulus silicone is extremely low, it is possible to form the protective rings **343***a* and **344***a* by taking advantage of flow of the low modulus silicone without moving the dispensing nozzle along the outer peripheries of the abutment members **341***a* and **342***a*.

Except for the above, the optical print head **300***a* according to the modification is the same as the optical print head **300**.

The wide portion as illustrated in FIG. **7**C can be applied to the optical print heads **300** and **300***a*. Also, the through holes and abutment members filling them illustrated in FIGS. **9**A to **9**C can be applied to the optical print heads **300** and **300***a*.

4 Fourth Embodiment

<4-1> Structure

FIG. **15** is a sectional view schematically illustrating a structure of an optical print head **400** according to a fourth embodiment of the present invention. FIG. **16** is a sectional view taken along line S**16**-S**16** in FIG. **15**. FIG. **17** is a sectional view taken along line S**17**-S**17** in FIG. **15**. FIG. **18** is a perspective view schematically illustrating the structure of the optical print head **400** according to the fourth embodiment. FIG. **19** is a sectional view schematically illustrating the structure of a main part of the optical print head **400** according to the fourth embodiment.

As illustrated in FIGS. **15** to **19**, the optical print head **400** is an exposure device for illuminating the surface **161** of the photosensitive drum **160** that faces the optical print head **400** via spacers **451** and **452**. The optical print head **400** includes the mounting substrate (or board) **110** on which the light emitting element array **111** is mounted, the lens array **120** that focuses light emitted from the light emitting element array **111** onto the surface **161** of the photosensitive drum **160**, and a holder (or lens holder) **430** as a holding member that holds the mounting substrate **110** and lens array **120**. The light emitting array **111** includes multiple light emitting elements arranged in the x direction.

The mounting substrate **110** is held by a base **435** disposed inside the holder **430**. The holder **430** has an opening (or slot) **432** formed at a central part of a support surface **431** and elongated in the x direction. The lens array **120** is inserted in the opening **432**. The lens array **120** is positioned so that the distance Lo between the surface of the light emitting element array **111** and the first surface **121** of the lens array **120** is an optimum distance for characteristics of the lens array **120** and is fixed to the holder **430** at the optimum position with adhesive.

To accurately focus or image light emitted from the light emitting element array **111** on the surface **161** of the photosensitive drum **160**, it is necessary to adjust the distance Li between the second surface **122** of the lens array **120** and the surface **161** of the photosensitive drum **160** so that the distance Li is equal (or substantially equal) to the distance Lo between the light emitting surface of the light emitting element array **111** and the first surface **121** of the lens array **120**, i.e., Lo=Li (or Lo≈Li when an error is taken into account). Thus, an abutment member **441** as a first spacer member and an abutment member **442** as a second spacer member are disposed at positions facing spacers **451** and **452** that abut (or are slidably in contact with) the surface **161** of the photosensitive drum **160**. The abutment members **441** and **442** are disposed near both ends of the holder **430** in the longitudinal direction (or x direction). The abutment members **441** and **442** are made of resin. The abutment members **441** and **442** are plates as positioning members for adjusting the distance Li and positioning the holder **430** in the z direction. The spacers **451** and **452** are disposed to abut surfaces of the abutment members **441** and **442** and the surface **161** of the photosensitive drum **160**. In the fourth embodiment, the distance Li between the surface **161** of the photosensitive drum **160** and the second surface **122** of the lens array **120** is set or defined by the spacers **451** and **452**, the abutment members **441** and **442**, and adhesives (or bodies of adhesive) **443** and **444**.

Springs **436** and **437** as urging members are disposed near both ends of the holder **430** in the longitudinal direction (or x direction). The springs **436** and **437** urge the optical print head **400** in a direction (or the z direction) toward the photosensitive drum **160**, and the abutment members **441** and **442** as positioning members are positioned and fixed with the UV curable adhesives **443** and **444**, which are adhesives made of curable resin, so that Lo=Li (or Lo≈Li when an error is taken into account).

<4-2> Manufacturing Method

A method of manufacturing the optical print head **400** for illuminating the photosensitive drum **160** that faces the optical print head **400**.

FIG. **20**A is a perspective view schematically illustrating a structure of the optical print head **400** according to the fourth embodiment. FIG. **20**B is a perspective view schematically illustrating a process of positioning the abutment members **441** and **442** of the optical print head **400** according to the fourth embodiment. FIG. **21** is a sectional view schematically illustrating the process of positioning the abutment members **441** and **442** of the optical print head **400** according to the fourth embodiment. An example of a method for positioning the abutment members **441** and **442**, which are the positioning members, so that Lo=Li (or Lo≈Li when an error is taken into account) will be described below.

First, the shapes of the abutment members **441** and **442** and the shapes of portions of the holder **430** on which the abutment members **441** and **442** are mounted will be described. Each of the abutment members **441** and **442** has a rectangular parallelepiped shape. The abutment members **441** and **442** are preferably made of material that transmits light (e.g., transparent material). In this example, the abutment members **441** and **442** are made of plastic resin that transmits light (or transparent plastic resin). However, the abutment members **441** and **442** may have other shapes as long as the abutment members **441** and **442** can abut the spacers to maintain the distance Li. Recesses **433** and **434** on which the abutment members **441** and **442** are to be mounted are formed in the holder **430**, on which the abutment members **441** and **442** are mounted. The recesses **433** and **434** are formed near both ends of the holder **430** in the longitudinal direction (or main scanning direction). The recesses **433** and **434** are slightly larger than the abutment members **441** and **442**. The UV curable adhesives **443** and **444** as curable resins are dropped or supplied into the recesses **433** and **434**. The abutment members **441** and **442** are placed in the recesses **433** and **434** with the UV curable adhesives **443** and **444** between the abutment members **441** and **442** and the recesses **433** and **434**. The UV curable adhesives **443** and **444** are irradiated with UV light to fix the abutment members **441** and **442** to the holder **430**.

Next, a height H at which the abutment members **441** and **442** are mounted will be described. The abutment members **441** and **442** are positioning members for making the distance Li equal (or substantially equal) to the distance Lo. As illustrated in FIG. **19**, with the second surface **122** of the

lens array **120** as a reference, the mounting height H of the abutment members **441** and **442** is equal to the absolute value of the difference between a height Ha of the spacers **451** and **452** mounted on the surface **161** of the photosensitive drum **160** and the distance Li. This is represented by the equation: H=|Ha−Li|. Thus, the distance between the second surface **122** of the lens array **120** and abutment surfaces (or lower ends in FIGS. **19** and **21**) of the abutment members **441** and **442** can be represented by the difference between the height Ha of the spacers **451** and **452** mounted on the surface **161** of the photosensitive drum **160** and the distance Li, and it is possible to make the distance Li equal (or substantially equal when an error is taken into account) to the distance Lo by adjusting the height H. Specifically, since the distance Li can be represented by Li=Ha−H, it is possible to make the distance Li equal (or substantially equal when an error is taken into account) to the distance Lo by setting the height H to (Ha−Lo).

Next, a method of positioning the abutment members **441** and **442** so that Lo=Li (or Lo≈Li) will be described. A jig **800** includes reference blocks **871** and **872** having abutment surfaces **871***a* and **872***a* against which the abutment surfaces of the abutment members **441** and **442** abut, and a reference block **873** having abutment surfaces **873***a* against which both ends of the second surface **122** of the lens array **120** in the longitudinal direction abut. The jig **800** is configured so that heights of the abutment surfaces **871***a* and **872***a* can be adjusted with a height of the abutment surfaces **873***a* as a reference. On the basis of the holder **430** to which the lens array **120** has been fixed so that the distance Lo between the surface of the light emitting element array **111** and the first surface **121** of the lens array **120** is the optimum distance for characteristics of the lens array **120**, to set the height H of the abutment surfaces of the abutment members **441** and **442** relative to the second surface **122** of the lens array **120** to a height satisfying Lo=Li (or Lo≈Li) using the jig **800**, the heights of the abutment surfaces **871***a* and **872***a* relative to the abutment surfaces **873***a* are adjusted to |Ha−Lo|. Then, the abutment members **441** and **442** are placed on the abutment surfaces **871***a* and **872***a* of the jig **800**, and attracted by air suction or other ways. Thereby, the abutment members **441** and **442** are in close contact with and held on the abutment surfaces **871***a* and **872***a* of the reference blocks **871** and **872** of the jig **800**.

Next, the UV curable adhesives **443** and **444** are dropped into the recesses **433** and **434** of the holder **430** to which the lens array **120** has been fixed with adhesive so that the distance Lo between the surface of the light emitting element array **111** and the first surface **121** of the lens array **120** is the optimum distance for characteristics of the lens array **120**. Then, the holder **430** is positioned relative to the jig **800** by fitting pins **871***b* and **872***b* formed on the reference blocks **871** and **872** into a fitting groove **439** (FIG. **20**A) and a fitting hole **438** (FIG. **20**A) formed in the holder **430**. Then, the holder **430** is moved until the second surface **122** of the lens array **120** abuts the abutment surfaces **873***a* of the reference block **873**. Then, the second surface **122** of the lens array **120** is attracted by air suction or other ways to be brought into close contact with the abutment surfaces **873***a*, and the holder **430** with the lens array **120** fixed thereto is held on the abutment surfaces **873***a*.

Next, the UV curable adhesives **443** and **444** are irradiated with UV light through the abutment members **441** and **442** to be cured, thereby fixing the abutment members **441** and **442** to the holder **430**. Thereby, the abutment members **441** and **442** are positioned so that Lo=Li (or Lo≈Li). In the fourth embodiment, since it is efficient to irradiate the UV curable adhesives **443** and **444** with UV light through the abutment members **441** and **442** to cure the UV curable adhesives **443** and **444**, the abutment members **441** and **442** are made of material that transmits light (or transparent material). However, the abutment members **441** and **442** may be made of non-transparent material as long as the UV curable adhesives **443** and **444**, which have been dropped at the positions facing the abutment surfaces of the abutment members **441** and **442**, can be cured. As above, the holder **430** with the lens array **120** and abutment members **441** and **442** mounted thereon is formed.

<4-3> Advantages

As described above, in the optical print head **400** according to the fourth embodiment and the manufacturing method thereof, with the second surface **122** of the lens array **120** as a reference, the abutment members **441** and **442** are positioned and fixed to the holder **430** using the jig **800** so that Lo=Li (or Lo≈Li). This makes it possible to reduce the number of parts, downsize the optical print head, reduce the assembly time, or reduce the cost of the optical print head.

Further, the UV curable adhesives **443** and **444** are disposed to face abutment surfaces (flat surfaces) of the abutment members **441** and **442**. Thus, when the optical print head **400** is urged toward the photosensitive drum **160**, forces are exerted on wide surfaces of the UV curable adhesives **443** and **444** perpendicularly to the wide surfaces. Thus, even when the positions or dimensions of the abutment members **441** and **442** vary with environment or time, the variation is less likely to adversely affect the UV curable adhesives **443** and **444**.

5 Fifth Embodiment

<5-1> Structure

FIG. **22** is a sectional view schematically illustrating a structure of an optical print head **500** according to a fifth embodiment of the present invention. FIG. **23** is a perspective view schematically illustrating a structure of a main part of the optical print head **500** according to the fifth embodiment. FIG. **23** includes a sectional view taken along line S**23**-S**23** in FIG. **22**. FIG. **24** is an exploded perspective view schematically illustrating the structure of the main part of the optical print head **500** according to the fifth embodiment.

As illustrated in FIGS. **22** to **24**, the optical print head **500** is an exposure device for illuminating the surface **161** of the photosensitive drum **160** that faces the optical print head **500** via spacers **551** and **552**. The optical print head **500** includes the mounting substrate **110** on which the light emitting element array **111** is mounted, the lens array **120** that focuses light emitted from the light emitting element array **111** onto the surface **161** of the photosensitive drum **160**, and a holder (or lens holder) **530** as a holding member that holds the mounting substrate **110** and lens array **120**. The light emitting array **111**, which may be composed of multiple light emitting element array chips, includes multiple light emitting elements arranged in the x direction. The lens array **120** includes, for example, multiple microlenses (e.g., erecting equal magnification imaging lenses) arranged in a regular manner. As illustrated in FIG. **22**, the lens array **120** has the first surface **121** and the second surface **122**. The first surface **121** is the end surface on the light emitting element array **111** side of the lens array **120** and is the light incident surface. The second surface **122** is the end surface on the photosensitive drum **160** side of the lens array **120** and is the light emitting surface.

As illustrated in FIGS. **22** to **24**, the optical print head **500** further includes abutment members **541** and **542** as an

abutment portion provided on the holder **530**. The abutment members **541** and **542** are disposed near both ends of the holder **530** in the longitudinal direction (or x direction). As illustrated in FIG. **22**, the abutment member **541** as a first spacer member abuts the spacer **551**. The abutment member **542** as a second spacer member abuts the spacer **552**. The abutment members **541** and **542** and the spacers **551** and **552**, which slide on the surface **161** of the photosensitive drum **160**, set or define the clearance or distance Li between the second surface **122** of the lens array **120** and the surface **161** of the photosensitive drum **160**.

The holder **530** has a support surface **531** that faces the photosensitive drum **160**, and an opening (or slit) **532** formed in the support surface **131** and elongated in the x direction. The opening **532** is a through hole in which the lens array **120** is inserted. The lens array **120** is inserted in the opening **532** with its longitudinal direction parallel to the x direction, and is fixed to the support surface **531** of the holder **530** with adhesive (e.g., UV adhesive). To prevent foreign matter, such as toner, from entering the inside (or light emitting element array **111** side) of the holder **530**, it is preferable that a space around the lens array **120** in the opening **532** of the holder **530** be sealed by the sealing member **133** surrounding the lens array **120**.

To set the distance Lo between the surface of the light emitting element array **111** and the first surface **121** of the lens array **120** to a predetermined distance, the mounting substrate **110** is placed on substrate spacers **539** fixed to the holder **530**, and is pressed against the substrate spacers **539** (in the +z direction) by a pressure member **535**, such as a spring, to be fixed. The lens array **120** is fixed to the holder **530** so that the distance Lo is an optimum distance for characteristics of the lens array **120**. The abutment members **541** and **542** are disposed near both ends of the holder **530** in the x direction to face the spacers **551** and **552** placed on the surface **161** of the photosensitive drum **160**. The positions of the abutment members **541** and **542** are adjusted so that the distance Li between the second surface **122** of the lens array **120** and the surface **161** of the photosensitive drum **160** is equal (or substantially equal when an error is taken into account) to the distance Lo.

<5-2> Manufacturing method

A method of manufacturing the optical print head **500** for illuminating the photosensitive drum **160** that faces the optical print head **500** will be described. First, the abutment members **541** and **542** are fitted into the holder **530** holding the mounting substrate **110** with the light emitting element array **111** and the lens array **120** for focusing or imaging light emitted from the light emitting element array **111**, and UV curable adhesives (or bodies of UV curable adhesive) **580**, which are curable resins before being cured, are supplied between the abutment members **541** and **542** and the holder **530**. Then, an image imaged by the lens array **120** is observed by an observation device, and thicknesses of the UV curable adhesives **580** are adjusted on the basis of the observed image. Then, the UV curable adhesives are cured, thereby setting heights (or shapes) of the abutment members **541** and **542**.

Next, the method of manufacturing the optical print head **500** will be described in more detail. FIGS. **25** and **26** are sectional views schematically illustrating a process of manufacturing the optical print head **500** according to the fifth embodiment.

The shape of the abutment member **541** and the shape of a portion of the holder **530** on which the abutment member **541** is mounted will be described. The abutment member **542** has the same structure as the abutment member **541**. As illustrated in FIGS. **23** and **24**, the abutment member **541** is made of resin material. The abutment member **541** has: four L-shaped elastic portions **541***a* formed at four corners of the abutment member **541**; a sliding rib **541***b* formed between two of the four L-shaped elastic portions **541***a* on the +y side and the other two of the four L-shaped elastic portions **541***a* on the −y side; and two mounting portions **541***c* having a convex shape and formed on a surface opposite the L-shaped elastic portions **541***a* (or on an opposite side of the L-shaped elastic portions **541***a* in the z direction). The holder **530** can be produced by sheet-metal press working. The holder **530** has folded portions **536** formed at positions outside the lens array **120** in the x direction by folding both sides inward in a transverse direction (or the y direction), and holder slit portions **537** formed on both sides of each of the folded portions **536**. The L-shaped elastic portions **541***a* of the abutment member **541** are inserted in the holder slit portions **537**. The sliding rib **541***b* is inserted between the folded portions **536**. The UV curable adhesives (or UV curable resin portions) **580**, which are an example of curable resins, that are cured by UV radiation are dropped or supplied onto the folded portions **536** as illustrated in FIG. **25**, and are pressed by the abutment member **541** as illustrated in FIG. **26**. In a state where the abutment member **541** is mounted on the holder **530** with no load applied thereto, a clearance is maintained between a bottom surface of the abutment member **541** and the folded portions **536**. The abutment member **542** is mounted on the holder **530** in the same manner as the abutment member **541**.

Next, as illustrated in FIGS. **25** and **26**, the holder **530** on which the lens array **120**, light emitting element array **111**, mounting substrate **110**, substrate spacers **539**, pressure member **535**, and abutment members **541** and **542** are mounted is set on a focus sensor device **570** including a sensor for detecting a focal position. The focus sensor device **570** has a sensor light receiving portion **571** for detecting the focal position and a sensor reference surface **572** against which the abutment members **541** and **542** abut. A distance between the sensor light receiving portion **571** and the sensor reference surface **572** is fixed at a virtual surface distance Lc that is equal to an ideal height (or designed height) of the spacers **551** and **552** from the surface **161** of the photosensitive drum **160**. The focus sensor device **570** determines a distance Lz from the second surface **122** of the lens array **120** to an imaging position of light emitted from the second surface **122** of the lens array **120** by the sensor light receiving portion **571**, and outputs a signal indicating the distance Lz. The output distance Lz is equal to the distance Li from the second surface **122** of the lens array **120** to the surface **161** of the photosensitive drum **160**.

Next, the holder **530** with the lens array **120** fixed thereto is moved in an optical system direction (or the ±z direction) by a lifting and lowering device (not illustrated) so that the distance Lz satisfies Lz=Lo=Li, which is an optimum condition for characteristics of the lens array **120**. As the holder **530** moves up (or in the +z direction), the abutment members **541** and **542** are pressed against the sensor reference surface **572** of the focus sensor device **570** by the slit portions **537** to elastically deform so that the L-shaped elastic portions **541***a* move up as illustrated in FIG. **26**. Then, as the holder **530** moves down (or in the −z direction), the abutment members **541** and **542** are released from the pressure to deform back to the shapes when no load is applied to them as illustrated in FIG. **25**. The holder **530** is moved up and down (or in the ±z direction) and thereby positioned so that the condition Lz=Lo=Li is satisfied. In this position, the UV curable adhesives **580** supplied

between the folded portions **536** and the bottom surfaces of the abutment members **541** and **542** are cured by a UV irradiator (not illustrated), thereby fixing the positions of the abutment members **541** and **542** relative to the holder **530**.

<5-3> Advantages

As above, in the optical print head **500** according to the fifth embodiment, when the distance Li is adjusted, the abutment members **541** and **542** are pressed and the L-shaped elastic portions **541***a* are elastically deformed; after the distance Li is adjusted, the abutment members **541** and **542** are fixed to the holder **530**. This can simplify the shape of the holder **530** and the structure of the optical print head **500**, and reduce the number of parts, thereby reducing the cost of the optical print head **500**.

Further, as illustrated in FIG. **26**, the UV curable adhesives **580** are disposed between the abutment members **541** and **542** and the folded portions **536** facing the abutment members **541** and **542** in the z direction. Thus, when the optical print head **500** is pressed in the z direction, the UV curable adhesives **580** are subjected to a force in the z direction and no force in the x and y directions, and therefore the cured UV curable adhesives **580** are less likely to deform.

<5-4> Modification

FIG. **27** is a sectional view schematically illustrating a structure of an optical print head **500***a* according to a modification of the fifth embodiment. In FIG. **27**, elements that are the same as or correspond to those in FIG. **25** have the same reference characters. The optical print head **500***a* illustrated in FIG. **27** differs from the optical print head **500** illustrated in FIGS. **22** to **26** in having abutment members **561** simpler than the abutment members **541** and **542** and using coil springs **562** and adhesives (or UV curable adhesives) that fix the coil springs **562** (or their shapes) instead of the UV curable adhesives **580**. With the structure of FIG. **27**, it is possible to simplify the shapes of the abutment members **561** and reduce the cost. Except for the above, the optical print head **500***a* is the same as the optical print head **500**.

6 Sixth Embodiment

<6-1> Configuration

FIG. **28** is a sectional view schematically illustrating a configuration of an image forming apparatus **600** according to a sixth embodiment of the present invention. The image forming apparatus **600** is, for example, an electrophotographic color printer. The image forming apparatus **600** includes optical print heads **611**K, **611**Y, **611**M, and **611**C as exposure devices, each of which is one of the optical print heads described in the first to fifth embodiments and modifications thereof.

As illustrated in FIG. **28**, the image forming apparatus **600** includes as major components: image forming sections **610**K, **610**Y, **610**M, and **610**C that form developer images (or toner images) by electrophotography; a medium supply unit (or paper feeding unit) **620** that supplies a recording medium P, such as a sheet of paper, to the image forming sections **610**K, **610**Y, **610**M, and **610**C; a conveying unit **630** that conveys the recording medium P; transfer rollers **640** as transfer units that are arranged to correspond to the image forming sections **610**K, **610**Y, **610**M, and **610**C, and transfer the toner images formed by the image forming sections **610**K, **610**Y, **610**M, and **610**C onto the recording medium P; a fixing unit **650** that fixes the toner images transferred on the recording medium P onto the recording medium P; and a pair of paper discharging rollers **625** as a medium discharging unit that discharges the recording medium P passing through the fixing unit **650** outside the image forming apparatus **600**. FIG. **28** illustrates the four image forming sections **610**K, **610**Y, **610**M, and **610**C, but the number of image forming sections in the image forming apparatus **600** may be three or less, or five or more. The image forming apparatus **600** illustrated in FIG. **28** is a color printer, but the present invention is also applicable to a monochrome printer that includes a single image forming section and forms an image on a recording medium by electrophotography. The image forming apparatus **600** illustrated in FIG. **28** is a printer, but the present invention is also applicable to other apparatuses, such as copiers, facsimile machines, and multi-function peripherals (MFPs), that form images on recording media by electrophotography.

As illustrated in FIG. **28**, the medium supply unit **620** includes: a medium cassette (or paper sheet cassette) **621**; a paper feed roller (or hopping roller) **622** that feeds one by one recording media P loaded in the medium cassette **621**; a roller **623** that conveys the recording medium P fed from the medium cassette **621**; and a pair of rollers **624** that convey the recording medium P to the image forming sections **610**K, **610**Y, **610**M, and **610**C.

The image forming sections **610**K, **610**Y, **610**M, and **610**C form black (K), yellow (Y), magenta (M), and cyan (C) toner images, respectively. The image forming sections **610**K, **610**Y, **610**M, and **610**C are arranged along a medium conveying path from the upstream side to the downstream side in a medium conveying direction (indicated by arrows in FIG. **28**). The image forming sections **610**K, **610**Y, **610**M, and **610**C respectively include detachable image forming units **612**K, **612**Y, **612**M, and **612**C for the respective colors. The image forming units **612**K, **612**Y, **612**M, and **612**C arranged in series are provided corresponding to the respective colors of the image forming sections **610**K, **610**Y, **610**M, and **610**C. The image forming unit **612**C forms an image with cyan toner, the image forming unit **612**M forms an image with magenta toner, the image forming unit **612**Y forms an image with yellow toner, and the image forming unit **612**K forms an image with black toner. The image forming units **612**K, **612**Y, **612**M, and **612**C basically have the same configuration except for the color of toner.

The image forming sections **610**K, **610**Y, **610**M, and **610**C respectively include the optical print heads **611**K, **611**Y, **611**M, and **611**C as exposure devices for the respective colors.

Each of the image forming units **612**K, **612**Y, **612**M, and **612**C includes: a photosensitive drum **613** as an image carrier supported rotatably; a charging roller **614** as a charging member that uniformly charges a surface of the photosensitive drum **613**; and a developing device **615** that, after the optical print head **611**K, **611**Y, **611**M, or **611**C exposes the surface of the photosensitive drum **613** to form an electrostatic latent image thereon, supplies toner to the surface of the photosensitive drum **613** to form a toner image corresponding to the electrostatic latent image.

The developing device **615** includes: a toner container as a developer container that forms a developer storage space for storing the toner; a developing roller **616** as a developer carrier that supplies the toner to the surface of the photosensitive drum **613**; a supply roller **617** that supplies the toner stored in the toner container to the developing roller **616**; and a developing blade **618** as a toner regulating member that regulates the thickness of a toner layer on a surface of the developing roller **616**.

Each of the optical print heads **611**K, **611**Y, **611**M, and **611**C exposes the uniformly charged surface of the photo-

sensitive drum **613** based on image data for printing. Each of the optical print heads **611**K, **611**Y, **611**M, and **611**C includes at least one light emitting element array in which multiple light emitting elements (e.g., LED elements) are arranged in an axial direction of the photosensitive drum **613**.

As illustrated in FIG. **28**, the conveying unit **630** includes: a conveying belt (or transfer belt) **633** that conveys the recording medium P while electrostatically attracting it; a drive roller **631** that is rotated by a driver to drive the conveying belt **633**; and a tension roller (or driven roller) **632** that stretches the conveying belt **633** together with the drive roller **631**.

As illustrated in FIG. **28**, the transfer rollers **640** are disposed to face the respective photosensitive drums **613** of the image forming units **612**K, **612**Y, **612**M, and **612**C with the conveying belt **633** therebetween. The developer images (or toner images) formed on the surfaces of the respective photosensitive drums **613** of the image forming units **612**K, **612**Y, **612**M, and **612**C are sequentially transferred by the transfer rollers **640** onto the upper surface of the recording medium P conveyed along the medium conveying path in the direction indicated by the arrows in FIG. **28**, so that a color image in which the multiple toner images are superposed is formed.

The fixing unit **650** includes a pair of rollers **651** and **652** in pressure contact with each other. The roller **651** is a heat roller including a heater, and the roller **652** is a pressure roller pressed against the roller **651**. The recording medium P with the unfixed developer image (or toner image) passes between the pair of rollers **651** and **652** of the fixing unit **650**. At this time, the unfixed toner image is heated and pressed to be fixed onto the recording medium P.

<6-2> Operation

First, a recording medium P in the medium cassette **621** is fed by the hopping roller **622** to the registration roller **623**. Then, the recording medium P is conveyed from the registration roller **623** via the pair of rollers **624** to the conveying belt **633**, and conveyed to the image forming units **612**K, **612**Y, **612**M, and **6120** in accordance with travel of the conveying belt **633**. In the image forming units **612**K, **612**Y, **612**M, and **6120**, the surfaces of the photosensitive drums **613** are charged by the charging rollers **614**, and exposed by the optical print heads **611**K, **611**Y, **611**M, and **611**C, so that electrostatic latent images are formed. The thin-layered toners on the developing rollers **616** electrostatically adhere to the electrostatic latent images, so that toner images of the respective colors are formed. The toner images of the respective colors are transferred onto the recording medium P by the transfer rollers **640**, so that a color toner image is formed on the recording medium P. Toner remaining on the photosensitive drums **613** after the transfer is removed by cleaning devices (not illustrated). The recording medium P with the color toner image formed thereon is conveyed to the fixing unit **650**. In the fixing unit **650**, the color toner image is fixed onto the recording medium P, so that a color image is formed. The recording medium P with the toner image formed thereon is discharged to a paper sheet stacker by the pair of discharging rollers **625**.

<6-3> Advantages

The image forming apparatus **600** according to the sixth embodiment employs the optical print heads according to one of the first to fifth embodiments and modifications thereof. Thus, the cost of the image forming apparatus **600** can be reduced.

<7> Modifications

The present invention is not limited to the embodiments and modifications described above; it can be practiced in various other aspects without departing from the inventive scope.

Although the above description has illustrated examples in which the abutment members or the adhesives for fixing the abutment members are UV curable resins or UV curable adhesives, the abutment members or the adhesives for fixing the abutment members may be other curable resins, such as curable materials that are cured by curing accelerators, or curable materials that are cured by temperature change (or heating).

Further, although the above description has illustrated examples in which the abutment members are transparent resins that transmit light, the abutment members need not necessarily be transparent.

Further, the structures of the first to fifth embodiments and modifications thereof may be combined appropriately.

What is claimed is:

1. An optical print head for illuminating an image carrier that faces the optical print head, the optical print head comprising:

a substrate on which a light emitting element array is mounted;

a lens array for focusing light emitted from the light emitting element array onto the image carrier;

a holder holding the substrate and the lens array; and

at least one spacer member, disposed on the holder, for maintaining a predetermined distance between the lens array and the image carrier, the at least one spacer member being made of curable resin that is cured under a predetermined condition or fixed to the holder with curable adhesive that is cured under a predetermined condition.

2. The optical print head of claim **1**, wherein the curable resin is one of ultraviolet curable resin that is cured by exposure to ultraviolet light, thermosetting resin that is cured by heating, and curable resin that is cured by a curing accelerator.

3. The optical print head of claim **1**, wherein the curable adhesive is one of ultraviolet curable adhesive that is cured by exposure to ultraviolet light, adhesive that is cured by heating, and adhesive that is cured by a curing accelerator.

4. The optical print head of claim **1**, wherein the at least one spacer member comprises:

a first spacer member disposed on one side of the lens array in a main scanning direction of the lens array; and

a second spacer member disposed on another side of the lens array in the main scanning direction.

5. The optical print head of claim **1**, wherein the at least one spacer member comprises:

a first spacer member disposed on one side of the lens array in a main scanning direction of the lens array; and

a second spacer member and a third spacer member disposed on another side of the lens array in the main scanning direction, and

wherein the second spacer member and the third spacer member are spaced from each other in a sub scanning direction perpendicular to the main scanning direction.

6. The optical print head of claim **1**, wherein the at least one spacer member includes an elastic portion in contact with the holder, and

wherein the at least one spacer member is fixed to the holder with the curable adhesive in a state in which the elastic portion is elastically deformed.

7. The optical print head of claim **5**, wherein the holder has a support surface,

wherein the support surface has a wide portion that is wide in the sub scanning direction, and

wherein the second spacer member and the third spacer member are disposed on the wide portion and spaced from each other in the sub scanning direction.

8. The optical print head of claim **1**, wherein the holder has a support surface, and

wherein the at least one spacer member is fixed on the support surface.

9. The optical print head of claim **1**, wherein the holder has a support surface having at least one through hole, and

wherein the at least one spacer member is fixed in the at least one through hole.

10. The optical print head of claim **1**, wherein the holder has a support surface having at least one recess, and

wherein the at least one spacer member is fixed in the at least one recess.

11. The optical print head of claim **1**, further comprising a protective ring disposed to surround an outer periphery of the at least one spacer member.

12. The optical print head of claim **1**, wherein the at least one spacer member is made of material that transmits ultraviolet light.

13. An image forming apparatus comprising:

an image carrier; and

the optical print head of claim **1** that illuminates the image carrier with light based on image data.

14. A method of manufacturing an optical print head for illuminating an image carrier that faces the optical print head, the method comprising:

placing a curable resin on a holder holding a substrate on which a light emitting element array is mounted and a lens array for focusing light emitted from the light emitting element array onto the image carrier;

adjusting a height of the curable resin in a direction from the lens array to the image carrier; and

curing the curable resin to form a cured product as a spacer member for maintaining a predetermined distance between the lens array and the image carrier.

15. The method of claim **14**, wherein the curable resin is one of ultraviolet curable resin that is cured by exposure to ultraviolet light, thermosetting resin that is cured by heating, and curable resin that is cured by a curing accelerator.

16. A method of manufacturing an optical print head for illuminating an image carrier that faces the optical print head, the method comprising:

placing, on a holder holding a substrate on which a light emitting element array is mounted and a lens array for focusing light emitted from the light emitting element array onto the image carrier, a spacer member for maintaining a predetermined distance between the lens array and the image carrier, and a curable adhesive;

adjusting a height of the spacer member in a direction from the lens array to the image carrier; and

curing the curable adhesive to fix the spacer member to the holder.

17. The method of claim **16**, wherein the curable adhesive is one of ultraviolet curable adhesive that is cured by exposure to ultraviolet light, adhesive that is cured by heating, and adhesive that is cured by a curing accelerator.

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